# CX 2000 Installation and Developer's Manual

**P/N 9000-62160-10**

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Refer to the NMS web site (*www.nmscommunications.com*) for product updates and for information about NMS support policies, warranty information, and service offerings.

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# Introduction

The *CX 2000 Installation and Developer's Manual* explains how to install and configure boards from the CX 2000 family of products. Specifically, it explains how to:

- Select a proper chassis for safety and heat considerations
- Install a CX 2000 board in a chassis
- Configure external power supplies
- Install the driver software
- Verify that the board has been installed correctly and is operating correctly
- Perform CT bus switching with CX 2000 boards

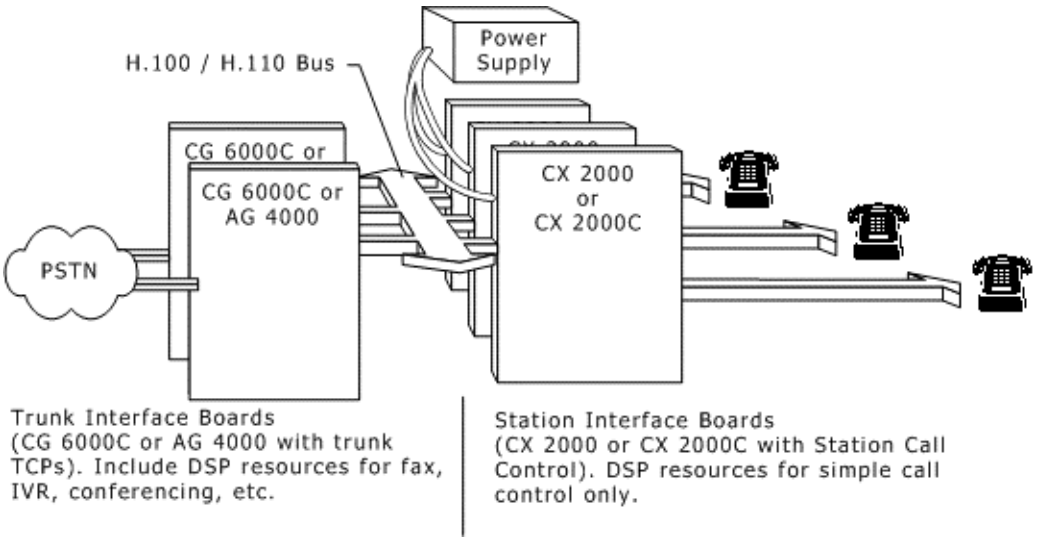
# Overview of the CX 2000 board family

## CX 2000 product family features

Boards in the CX 2000 family of products are station interfaces for Enterprise markets. They provide analog interfaces to analog devices such as telephones, fax machines, modems, etc. within a private network. They can be used to build such systems as Private Branch Exchanges, Automatic Call Distributors, and IP-PBXs.

In a system containing CX 2000 products, any communication with the public network is performed by trunk interface boards (such as CG 6000Cs or AG 4000s). CX 2000 or CX 2000C boards communicate with these boards over the H.100 or H.110 bus (see the following illustration).

CX 2000 products have sufficient on-board DSP resources for simple, low-level call control functions. More complex, resource-intensive operations (such as voice playing or recording) must be performed by other boards (such as the CG 6000C or AG 4000).


Power Supply
H.100 / H.110 Bus
CG 6000C or
CG 6000C or AG 4000
CX 2000 or CX 2000C
PSTN
Trunk Interface Boards (CG 6000C or AG 4000 with trunk TCPs). Include DSP resources for fax, IVR, conferencing, etc.
Station Interface Boards (CX 2000 or CX 2000C with Station Call Control). DSP resources for simple call control only.

*Typical system including CX 2000 or CX 2000C boards*

The CX 2000 product family consists of four board models. They differ in:

- The chassis each was designed for
- The number of stations each model supports
- The method each model uses to provide ring voltage to station phones.

The following table lists and describes each board model:

| Board model | Chassis type | Features | Limitations |
|---|---|---|---|
| CX 2000C-32 | CompactPCI (main board and rear transition board) | • Supports up to 32 stations<br>• Maximizes airflow and reduces heat<br>• Uses only J5 for telco lines<br>• Provides high ring capacity | • Requires external ring voltage supply |
| CX 2000C-32-R | CompactPCI (main board and rear transition board) | • Supports up to 32 stations<br>• Maximizes airflow and reduces heat<br>• Uses only J5 for telco lines<br>• Requires 24-32V DC talk battery power supply only | • Limited ring capacity (12 simultaneous ringing phones)<br>• Less than 2000 feet of cable to phone |
| CX 2000C-48 | CompactPCI (main board and rear transition board) | • Supports up to 48 stations<br>• Offers highest density for applications where number of stations simultaneously active is low<br>• Uses J3 and J5 for telco lines. (J3 must have proper safety clearance.)<br>• Provides high ring capacity | • Requires external ring voltage supply<br>• Requires chassis features described in the *CX 2000C Installation and Developer's Manual*<br>• Limited to applications where less than 24 stations are in continuous operation, due to heat issues |
| CX 2000-32 | PCI | • Supports up to 32 stations<br>• Provides high ring capacity | • Requires external ring voltage supply<br>• Requires a chassis with air flow considerations described in Selecting a PCI chassis<br>• UL and CSA requirements limit cabling to within the building |

CX 2000 and CX 2000C boards offer a standard set of station call control features. Functions such as playing, recording, and conferencing are performed by the trunk interface boards or other resource boards in the system.

The following table summarizes the features of each product in the family:

| Feature | CX 2000C-32 | CX 2000C-32-R | CX 2000C-48 | CX 2000-32 |
|---|---|---|---|---|
| Chassis type | CompactPCI | CompactPCI | CompactPCI | PCI |
| Number of ports | 32 | 32 | 48 | 32 |
| CT bus | H.110 | H.110 | H.110 | H.100 |
| Call center applications | Supported | Supported | NOT Supported | Supported |
| PBX applications | Supported | Supported | Supported | Supported |
| Detect on/off hook | Supported | Supported | Supported | Supported |
| Detect flash-hook | Supported | Supported | Supported | Supported |
| DTMF detection | Supported | Supported | Supported | Supported |
| DTMF generation | Supported | Supported | Supported | Supported |
| Dial tone | Supported | Supported | Supported | Supported |
| Call progress tones | Supported | Supported | Supported | Supported |
| CT bus switching API | Supported | Supported | Supported | Supported |
| Heart beat diagnostic | Supported | Supported | Supported | Supported |
| Transmit gain | Supported | Supported | Supported | Supported |
| Receive gain | Supported | Supported | Supported | Supported |
| Temperature sensors | Supported | Supported | Supported | Supported |
| On premise extensions | Supported | Supported | Supported | Supported |
| Off premise extensions | Supported | NOT Supported | Supported | NOT Supported |
| Wiring between buildings | Supported | Supported | Supported | NOT Supported<br>The PCI product is limited to inside cabling, due to both heat and safety power cross certification. |
| Internal ringing supply | NOT Supported | Supported | NOT Supported | NOT Supported |
| Easy chassis selection | Supported | Supported | NOT Supported<br>Because the CX 2000C-48 exceeds the 32-line CompactPCI specification, selecting a chassis for these applications has special considerations. For details, see *CX 2000C Installation and Developer's Manual.* | NOT Supported<br>Selecting a PCI chassis with proper air flow is critical for multiple CX 2000-32 boards to operate. For details, see Selecting a PCI chassis. |
| Hot Swap | Supported | Supported | Supported | NOT Supported |

The CX 2000C fully supports the H.110 bus specification. The CX 2000 fully supports the H.100 bus specification. Switching for both boards is implemented with the T8100A chip. The T8100A offers full support for the H.110/H.100 bus within the H.110/H.100 architecture providing access to all 4096 slots on the bus.

On the boards, switch connections are allowed for up to 128 full duplex connections between local devices and the bus. Non-blocking switch connections are allowed between local devices.

## Power supply

To provide power for talk battery and for ringing station phones (if necessary), an external power supply is required. NMS Communications supplies a rack mount power supply chassis that can contain up to four interchangeable supply modules. Alternatively, you can obtain a power supply from another source. You can connect the power supply to each board.

For more information on choosing and connecting power supplies, refer to Using the NMS rack mount power supply chassis.

## Developer's cable kit

To ease connecting telephones to CX 2000 boards, a developer's cable kit is available. It consists of the following components:

- Two RJ-21, twenty-five pair, 10 feet cables
- Two breakout boxes RJ-21 to 25 RJ-11

For more information about the developer's cable kit, refer to Connecting to station phones.

## Software components

CX 2000 boards require the following software components:

- The Natural Access development environment that provides application programming interfaces (APIs) for call control, voice store and forward, and switching.
- NMS OAM (Operations, Administration, and Maintenance), a Natural Access service that configures, administers, and maintains telephony resources in a system..
- The CX 2000 software package that includes the:
  - CX board plug-in
  - NMS OAM configuration files
  - CDI service DLLs and libraries that provide the call control functions on CX 2000 and CX 2000C boards
  - Device driver and downloadable firmware
  - *cxsw* switching driver

### *Natural Access*

Natural Access is a complete software development environment for voice applications. It provides a standard set of voice functions grouped into logical *services*. Each service has a standard programming interface. For more information about standard and optional Natural Access services, refer to the *Natural Access Developer's Reference Manual.*

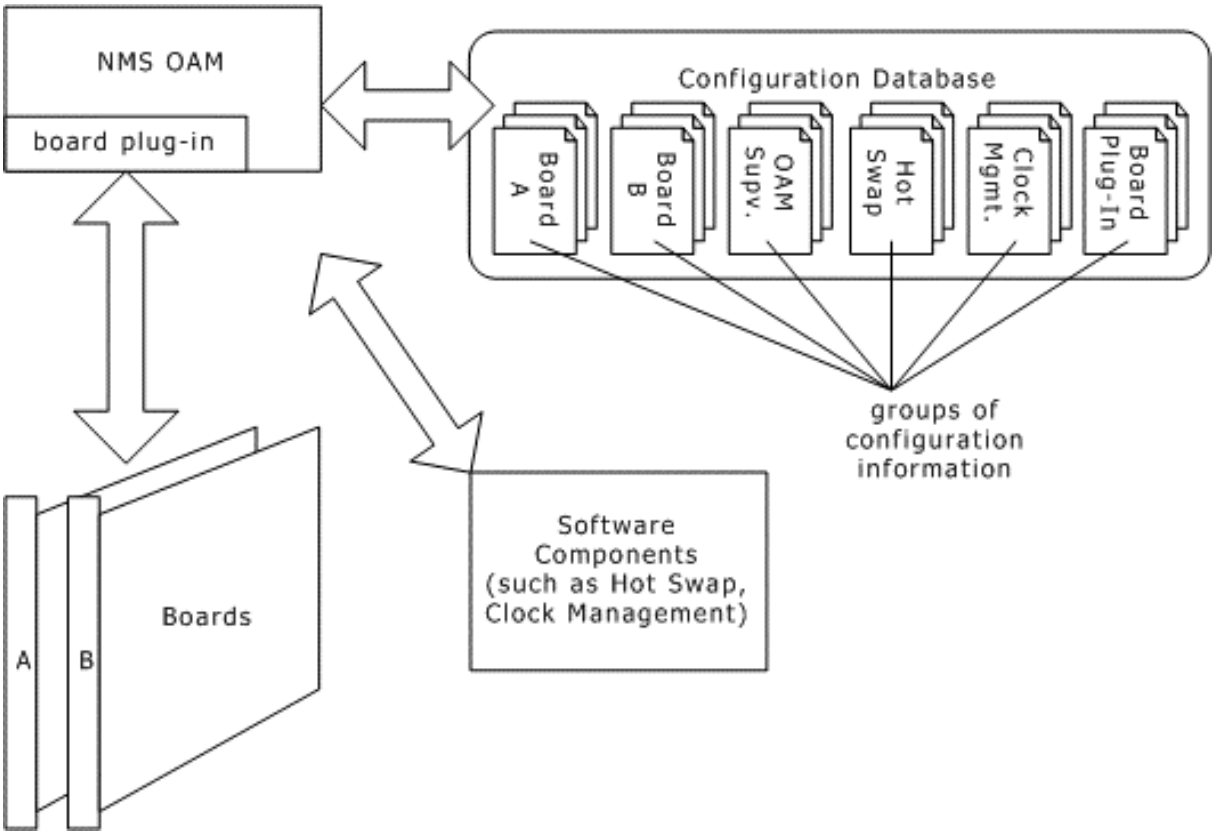
### *NMS OAM*

NMS Operations, Administration, and Maintenance (OAM) service manages and maintains the telephony resources in a system. These resources include hardware components (including CX boards) and low-level board management software modules (such as clock management).

Using NMS OAM, you can:

- Create, delete, and query the configuration of a component
- Start (boot), stop (shut down), and test a component
- Receive notifications from components

NMS OAM maintains a database containing records of configuration information for each component, as shown in the following illustration. This information consists of parameters and values.




*NMS OAM components*

Each NMS OAM database parameter and value is expressed as a keyword name/value pair (for example, Encoding = MuLaw). You can query the NMS OAM database for keyword values for any component. Keywords and values can be added, modified, or deleted.

**Note:** Before using NMS OAM or any of its related utilities, verify that *ctdaemon* is running. For more information about *ctdaemon*, refer to the *Natural Access Developer's Reference Manual*. For general information about NMS OAM and its utilities, refer to the *NMS OAM System User's Manual*.

## CX board plug-in

NMS OAM uses the CX board plug-in module to communicate with CX boards. The name of the CX plug-in is *cx.bpi*. The file must reside in one of the following directories in order for NMS OAM to load it when it starts up:

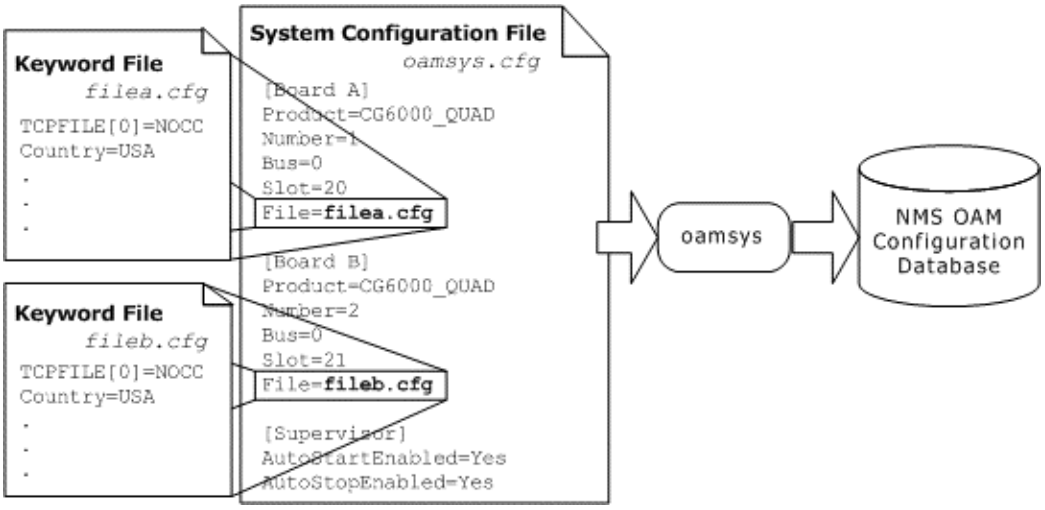
| Operating system | Path to cx.bpi |
|---|---|
| Windows 2000 | *\nms\bin* |
| UNIX | */opt/nms/bin* |

## NMS OAM configuration files

NMS OAM uses two types of configuration files:

| File Type | Description |
|---|---|
| System configuration | NMS OAM system configuration files contain a list of boards in the system and the name of one or more board keyword files for each board. |
| Board keyword | NMS OAM board keyword files contain parameters to configure the board (refer to the following illustration). These settings are expressed as keyword name and value pairs. |

Sample keyword files are installed with Natural Access. You can reference these files in your system configuration file or modify them.




*NMS OAM configuration files*

When you run the *oamsys* utility, it creates NMS OAM database records based on the contents of the specified system configuration file and board keyword files. It then directs the OAM service to start the boards, configured as specified. Refer to Configuring the system using oamsys for more information about configuration files and *oamsys*.

## CDI service

The CX Devices Interface (CDI) service is a Natural Access service that performs low-level station-oriented call control and board management functions for CX 2000 and CX 2000C boards. These functions include tone generation, DTMF detection, signaling, on-board timer actuation, temperature monitoring, power detection, and station module detection.

## CX driver software

The following drivers are installed with Natural Access for operating CX 2000 boards:

| Operating system | Driver names |
|---|---|
| Windows 2000 | *cxddrv.sys* |
| UNIX | *cx*<br>*cxsw* |

## Installation summary

The following table summarizes the steps required to install CX 2000 hardware and software components:

| Step | Description | For details, refer to... |
|---|---|---|
| 1 | Ensure that your PC system meets the system requirements. | System requirements |
| 2 | Install the board and connect it to station phones. | Installing the CX 2000 board |
| 3 | Connect a power supply. | Connecting a power supply |
| 4 | Install Natural Access (including Hot Swap), CX drivers, and NMS CAS protocols from the Natural Access CD. | The *Natural Access* installation booklet |
| 5 | Configure the system. | Configuring the system |
| 6 | Verify that your installation is operational. | Verifying the board installation |

# Installing a CX 2000 board

## System requirements

To install and use CX 2000 boards, your system must have

- An available PCI bus slot.
- The PCI version 2.2 compliant bus and BIOS.
- Natural Access version 4.0 or later installed.
- An uninterruptable power supply (UPS). Although a UPS is not strictly required, it is strongly recommended for increased system reliability. The UPS does not need to power the PC video monitor except in areas prone to severe lightning storms.
- An H.100 bus cable if you are connecting to any other H.100 boards.
- A grounded chassis with a three-prong power cord.
- Adequate cooling for the chassis. See Selecting a PCI chassis for more information.
- A power supply. For more information, refer to Using the NMS rack mount power supply chassis or to Using an alternative power supply.

| | |
|---|---|
| ***Caution:*** | *Each CX 2000 board is shipped in a protective anti-static container. Leave the board in its container until you are ready to install it. Handle the board carefully and hold it only by its handles. We recommend that you wear an anti-static wrist strap connected to a good earth ground whenever you handle the board.* |

## *Selecting a PCI chassis*

Use the following guidelines when choosing a chassis for the CX 2000 board:

- CX 2000 boards must be oriented vertically on the backplane to aid convection cooling. Avoid using a PC tower if you have more than two CX 2000 boards.
- In a large system (five or more slots) use at least one fan for every four slots. Use fans with a minimum rating of 40 cubic feet per minute (CFM) for blowing or drawing air lengthwise along the boards.
- In a smaller system (four or fewer slots) use fans that total at least 100 CFM for blowing or drawing air lengthwise along the boards.

Each chassis is different, and cooling is affected by such factors as:

- The distance between the fans on the boards
- The total volume of the chassis
- The pressure differential between the inside and outside of the chassis

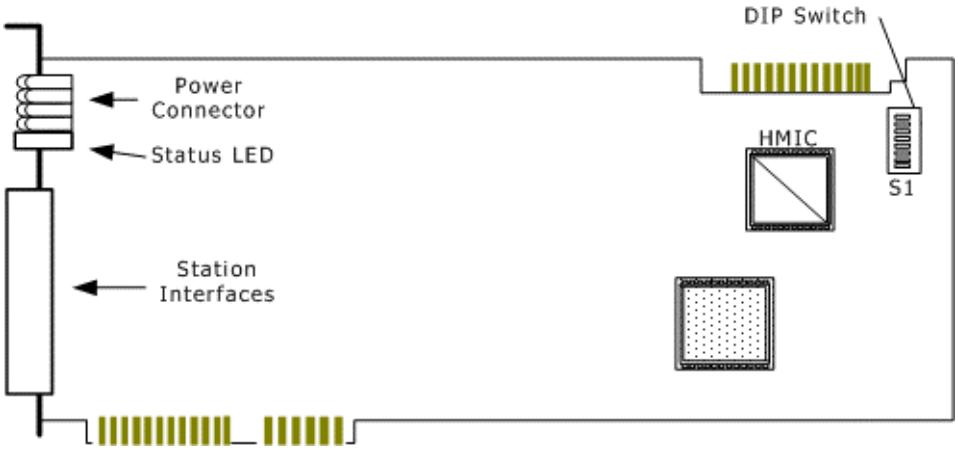
These guidelines are for a typical application. In some cases, more airflow may be necessary to ensure the board is operating at an acceptable temperature.

If you install an uninterrupted power supply, and use it to back up the NMS rack mount power supply (described in Using the NMS rack mount power supply chassis), it should be rated for a minimum of 1.8 kW.

| | |
|---|---|
| **WARNING:** | *This product will not boot in a PC chassis that does not conform to PCI specification version 2.2. If a PC was made before 1999, it probably does not conform to this specification.* |

## Board components

The following illustration shows where various components are located on a CX 2000 board:



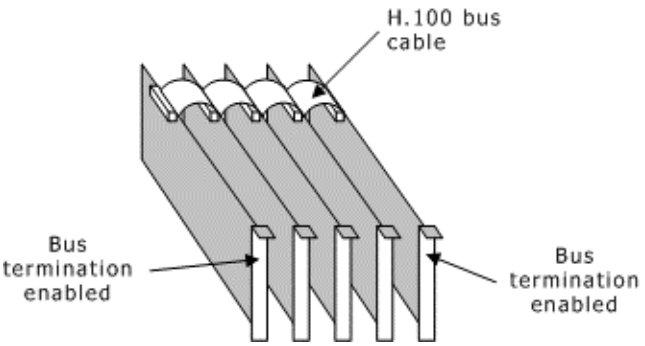

*CX 2000 board*

# Installing the CX 2000 board

This section presents procedures for configuring and installing the CX 2000 board in your system.

## *Terminating the H.100 bus*

In your system, the H.100 boards are connected to one another with an H.100 bus cable. The two boards located at the end of the H.100 bus must have bus termination enabled, as shown in the following illustration.



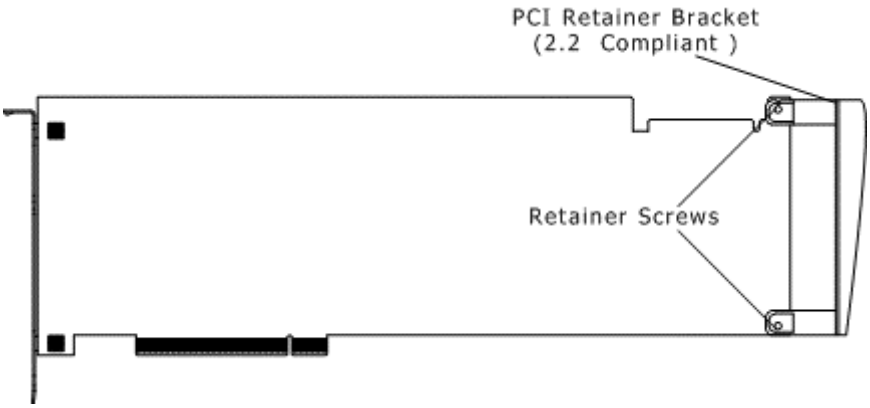

*CT bus termination*

DIP switch S1 (shown in the following illustration) controls the H.100 bus termination. The DIP switch is located on the component side of the CX 2000 board. By default, all switches are set to OFF (H.100 bus termination disabled). Setting all S1 switches to ON enables H.100 bus termination. Set all S1 switches to ON for the boards that are on the ends of the H.100 bus.

## *Installing the hardware*

To install a CX 2000 board in your system:

1. If necessary, configure bus termination as described in Terminating the H.100 bus.
2. Turn off the computer and disconnect it from the power source.
3. Remove the cover and set it aside.
4. If you are placing the board into:
    - A PCI chassis, remove the PCI retainer bracket by unscrewing it from the board. The bracket is not needed for the board to properly fit into the chassis.
    - An ISA chassis, leave the PCI retainer bracket attached to the board. The bracket is needed for the board to properly fit into the chassis.




*PCI retainer bracket*

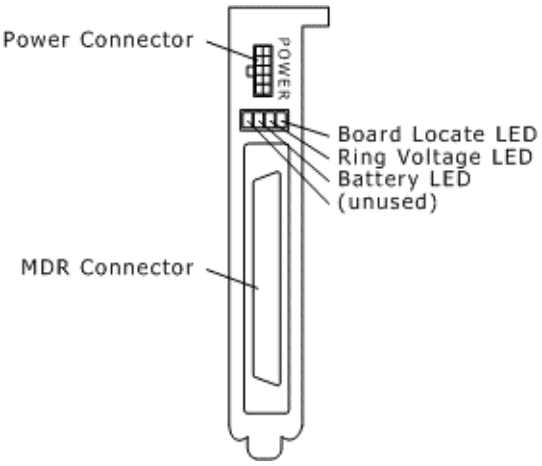
5. Arrange the CX 2000 board and other H.100 boards in adjacent PCI bus slots.
6. Make sure each board's PCI bus connector is seated securely in a slot.
7. Secure the end bracket on the CX 2000 board to the PC.
8. Connect the H.100 bus cable to the CX 2000 board.
9. If you have multiple H.100 boards, connect the H.100 bus cable to each of the H.100 boards.
10. Replace the cover, and connect the computer to its power source.
11. Install the CX software as described in the Natural Access installation booklet.
12. Connect station phones to the board as described in Connecting to station phones.
13. Connect a power supply to the board as described in Using the NMS rack mount power supply chassis or to Using an alternative power supply.

## Connecting to station phones

This section provides instructions for connecting telephones to the CX 2000 board.

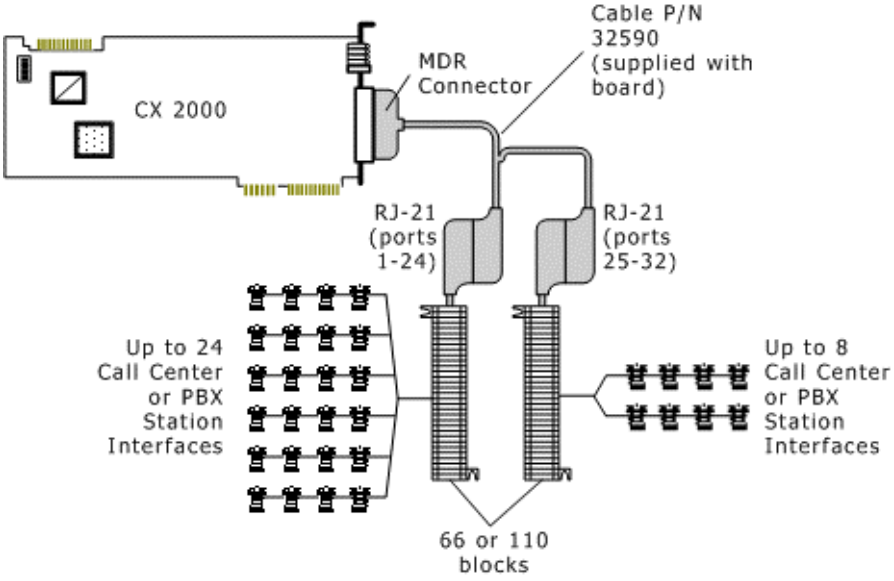
The CX 2000 board can connect to local telephones through up to 2000 feet of cable. Lines from local telephones to the CX 2000 board cannot run outside the building.

The station interface connector on the CX 2000 is a single MDR 68 pin connector on the end bracket (shown in the following illustration):



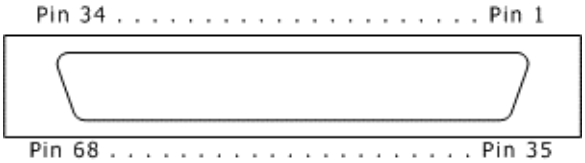

*Connectors on a CX 2000 board*

The CX 2000 board ships with one 3-foot cable (NMS P/N 32590) with an MDR 68 connector on one end and two RJ-21 connectors on the other. The stations are connected to the RJ-21 connectors using 66 or 110 blocks, as shown in the following illustration:




*Connecting the CX 2000 board to stations*

The following illustration shows the pin locations for each RJ-21 connector on the cable:



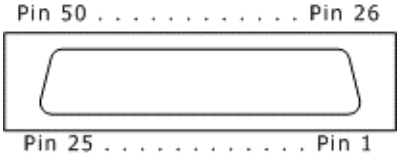

*Pinouts for MDR-68 connector on CX 2000 board*

The following table shows the pinouts for the MDR 68 connector:

| Station | Ring pin | Tip pin | | Station | Ring pin | Tip pin |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | | 17 | 36 | 37 |
| 2 | 4 | 5 | | 18 | 38 | 39 |
| 3 | 6 | 7 | | 19 | 40 | 41 |
| 4 | 8 | 9 | | 20 | 42 | 43 |
| 5 | 10 | 11 | | 21 | 44 | 45 |
| 6 | 12 | 13 | | 22 | 46 | 47 |
| 7 | 14 | 15 | | 23 | 48 | 49 |
| 8 | 16 | 17 | | 24 | 50 | 51 |
| 9 | 18 | 19 | | 25 | 52 | 53 |
| 10 | 20 | 21 | | 26 | 54 | 55 |
| 11 | 22 | 23 | | 27 | 56 | 57 |
| 12 | 24 | 25 | | 28 | 58 | 59 |
| 13 | 26 | 27 | | 29 | 60 | 61 |
| 14 | 28 | 29 | | 30 | 62 | 63 |
| 15 | 30 | 31 | | 31 | 64 | 65 |
| 16 | 32 | 33 | | 32 | 66 | 67 |

**Note:** Pins 1 and 68 are not used.

The following illustration shows the pin locations for each RJ-21 connector on the cable:




*Cable (NMS P/N 32590) Connector pinouts*

The following table lists the pinouts for the first RJ-21 connector on the cable:

| Station | Ring pin | Tip pin | | Station | Ring pin | Tip pin |
|---|---|---|---|---|---|---|
| 1 | 1 | 26 | | 13 | 13 | 38 |
| 2 | 2 | 27 | | 14 | 14 | 39 |
| 3 | 3 | 28 | | 15 | 15 | 40 |
| 4 | 4 | 29 | | 16 | 16 | 41 |
| 5 | 5 | 30 | | 17 | 17 | 42 |
| 6 | 6 | 31 | | 18 | 18 | 43 |
| 7 | 7 | 32 | | 19 | 19 | 44 |
| 8 | 8 | 33 | | 20 | 20 | 45 |
| 9 | 9 | 34 | | 21 | 21 | 46 |
| 10 | 10 | 35 | | 22 | 22 | 47 |
| 11 | 11 | 36 | | 23 | 23 | 48 |
| 12 | 12 | 37 | | 24 | 24 | 49 |

**Note:** Pins 25 and 50 are not used on this connector.

The following table lists the pinouts for the second RJ-21 connector on the cable:

| Station | Ring pin | Tip pin |
|---|---|---|
| 25 | 1 | 26 |
| 26 | 2 | 27 |
| 27 | 3 | 28 |
| 28 | 4 | 29 |
| 29 | 5 | 30 |
| 30 | 6 | 31 |
| 31 | 7 | 32 |
| 32 | 8 | 33 |

**Note:** Pins 9-25 and 34-50 are not used on this connector.

## *Developer's cable kit*

To help you get started, NMS provides an optional developer's cable kit (NMS P/N 80659). The kit contains two 10-foot RJ-21 cables and two breakout boxes. Each breakout box connects one RJ-21 to 24 standard RJ-11 (POTS) jacks for individual phones. You can use the cables to connect to the breakout boxes or to standard 66 or 110 blocks.

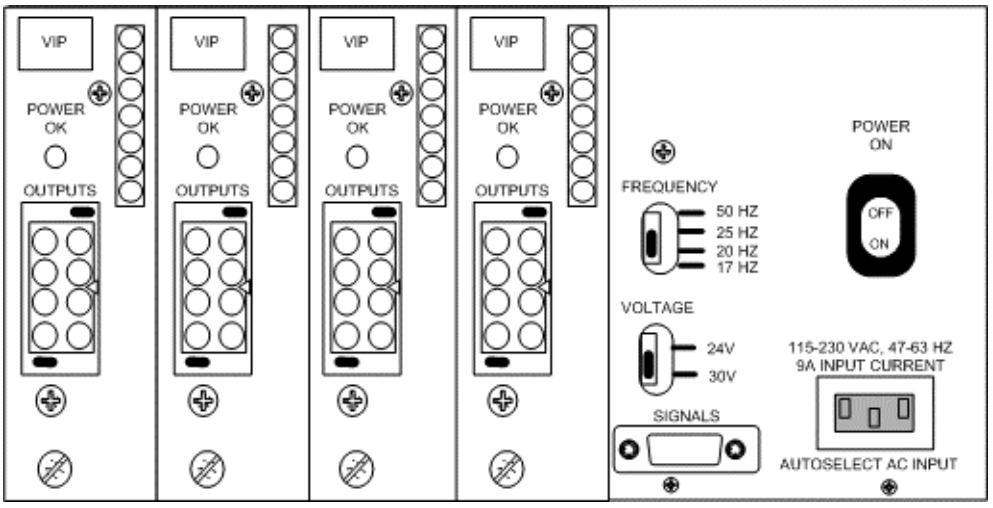
All components of the developer's cable kit sold by NMS are also commercially available from telephone product distributors such as Graybar and Anixter. These distributors can provide variations in cable lengths.

# Connecting a power supply

## Using the NMS rack mount power supply chassis

To supply talk battery power to the station phones and to power ringing (if necessary), an external power supply is required.

NMS supplies a rack mount power supply chassis that can contain up to four interchangeable supply modules. Each module can power up to two CX 2000 boards. Four modules produce a total combined output of 8.8A for
-48V and -30V/-24V. The ring output total is 0.68A. The supply outputs are isolated from ground and rely on the CX 2000 board to ground the return line. This provides the best EMI performance. (See the following illustration.)




*Rack mount power supply chassis and modules*

The power supply autoranges for global power standards, and can be configured for local ring frequency standards to satisfy global deployment requirements.

**Note:** Power supplies NMS P/N 2961 and NMS P/N 31468 used with S Connect and CX 1000 products are not compatible with CX 2000 boards.

## *Normal configuration*

The following table indicates the number of power supply chassis and modules you will need, based upon the number of CX 2000 boards in your system. The table assumes a normal configuration, in which all stations are active on each board. Sufficient ring signal is supplied so that for short (not continuous) peak demand periods, more than 20 phones rated at 1.0 REN can ring simultaneously.

| **Number of CX boards** | **Power supply chassis required**<br>**(Each chassis includes one power supply module)** | **Expansion modules required** |
|---|---|---|
| 1 | 1 | 0 |
| 2 | 1 | 0 |
| 3 | 1 | 1 |
| 4 | 1 | 1 |
| 5 | 1 | 2 |
| 6 | 1 | 2 |
| 7 | 1 | 3 |
| 8 | 1 | 3 |

## *Redundant power supply configuration*

To provide redundancy, or to supply additional ring power to your system, you can install one more power supply module then you need. The module-to-board connectors on all modules are wired in parallel, so if one module fails, another module supplies power to the first module's board connector. This helps ensure uninterrupted power to any connected boards in the unlikely event that a module fails.

If you connect the power supply to a UPS, the contribution of a fully populated power supply chassis is 1.8 kW.

The following table indicates the number of power supply chassis modules you will need, in a configuration in which an extra power supply module is installed:

| Number of CX boards | Power supply chassis required<br>(Each chassis includes one power supply module) | Expansion modules required |
|---|---|---|
| 1 | 1 | 1 |
| 2 | 1 | 1 |
| 3 | 1 | 2 |
| 4 | 1 | 2 |
| 5 | 1 | 3 |
| 6 | 1 | 3 |
| 7 | N/A | N/A |
| 8 | N/A | N/A |

When you have seven or eight CX boards, there is a maximum of four modules per chassis.

## *Rack mount considerations*

Consider the following items when installing a power supply in a rack:

- Do not block the power supply vents, or otherwise restrict airflow when installing the unit into a rack.
- Ensure that the rack is properly secured, so the rack is stable and cannot easily tip.
- Ensure that the electrical requirements of the system do not exceed the capacity of the electrical circuit.
- If an uninterrupted power supply is used to back up the rack mount supply, it should be rated for at least 1.8 kW.

**Note:** In the unlikely event that the power supply current exceeds the current rating, the power supply output clamps to zero to protect the supply. The power supply may need to be turned off momentarily and then turned back on to restore normal operation.

## *Connecting the NMS power supply*

You can connect power supply modules directly to CX 2000 boards.

NMS supplies two cables for these connections:

- NMS P/N 32523 (shipped with the module) - a cable with a male 8-pin Positronic connector on one end (to connect to the module), and two 10-pin MOLEX mini junior connectors on the other end to connect to the TELCO POWER connectors on CX 2000 boards.
- NMS P/N 32522 (can be ordered separately) - a cable with a male 8-pin Positronic connector on one end (to connect to the module), and #8 spade lugs on the other end to connect to the chassis telecom power bus.

### *Connecting directly to boards*

To connect the NMS power supply directly to each board:

1. On the power supply chassis, set the VOLTAGE switch to 24V.
2. On the power supply, set the FREQUENCY switch to a ringing frequency (default = 20 Hz).

   The default ringing frequency setting (20 Hz) will operate correctly in most applications. However, you can change this setting if a station does not ring when directed, or to change the sound of the ringer to match that of other devices in the target country or region.

| **WARNING:** | *Do not change the frequency or voltage while the power supply is operating.* |
|---|---|

Plug the Y end of the cable (NMS P/N 32523) into the TELCO POWER connectors on the CX 2000 boards.

Plug the other end of the cable into the power supply.

When you have finished configuring the power supply, plug it into a power source.

### *Alarm signal connector*

The NMS rack mount power supply has a DB9 connector on the rear panel which can be used to indicate an alarm condition. The following table lists the pinouts of this connector:

| Pin | Description |
|---|---|
| 1 | Chassis ground |
| 2 | 1.5K resistor to +12 V DC |
| 3 | 4.7K resistor to +5 V DC |
| 4 | Alarm signal output. This is an open collector NPN transistor with the emitter connected to COMMON. The transistor is normally on. It is turned off for an alarm condition. The transistor is rated for 20 V DC and 5 mA. The 4.7K resistor on pin 3 or pin 7 can provide pull-up to +5 V DC. |
| 5 | Optional signal |
| 6 | +5 V DC @ 3 mA |
| 7 | 4.7K resistor to +5 V DC |
| 8 | COMMON |
| 9 | COMMON |

## *Powering up the power supply*

To power up the supply, turn on the POWER ON switch located on the rear panel of the unit. When the unit is operating properly, the green POWER ON indicator on the front panel glows. In addition, the POWER ON indicator on each module glows (visible on the rear panel of the unit).

## Using an alternative power supply

You can use a power supply other than the NMS power supply. This power supply must provide:

- DC voltage to provide talk battery power to the station phones
- AC and DC ring voltage, if your application involves ringing station phones. The AC voltage provides the ringing power. The DC voltage provides loop current that signals the CX board when the phone goes on or off hook.

This section specifies the power supply requirements for different boards, and describes how to connect an alternative power supply.

**Note:** If you are using CX 2000-32-R boards with the on-board ringing option enabled, you do not need to provide external ring voltage. However, you still need to provide the talk battery power.

### *Power supply requirements*

The tables in the following sections specify power supply requirements for different boards, cable lengths and resistive loads.

Cables between the power supply and the board must be rated for 2A per board or greater. Twisted pair cabling is recommended for noise reduction.

| | |
|---|---|
| **WARNING:** | *In the worst case, the ring voltage must not exceed 92 V AC, and the DC voltage must not exceed 52 V DC.* |

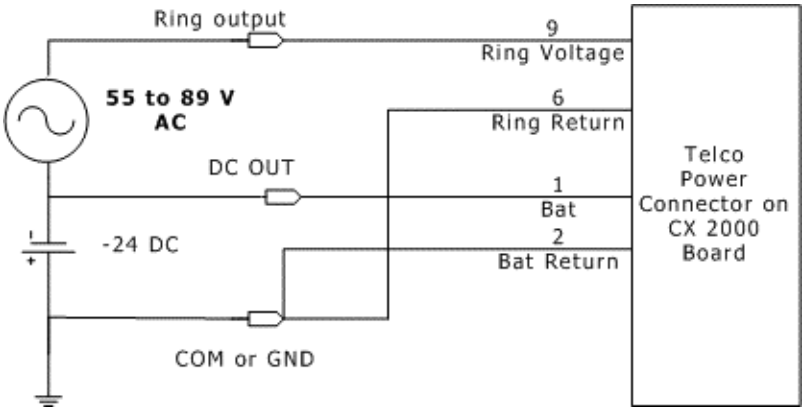
**Note:** The AG 2000 power supply can be substituted for the rack mount supply for one CX 2000 board. The cable supplied with the AG 2000 power supply will mate with the connector on the board.

#### *CX 2000 power supply requirements*

For CX 2000 boards, AC voltage is required only if you are enabling ringing of station phones.

| | | **Recommended output** | |
|---|---|---|---|
| **Length of 24 AWG cable** | **Max resistive load** | **Talk Battery** | **Ring voltage (only if ringing required)** |
| 0 to 2000 feet | 600 Ohms | -24VDC | 55 to 89VAC and -24VDC |
| > 2000 feet | Not supported. | | |

The ring signal circuitry in the power supply must be equivalent to the schematic shown in the following illustration:



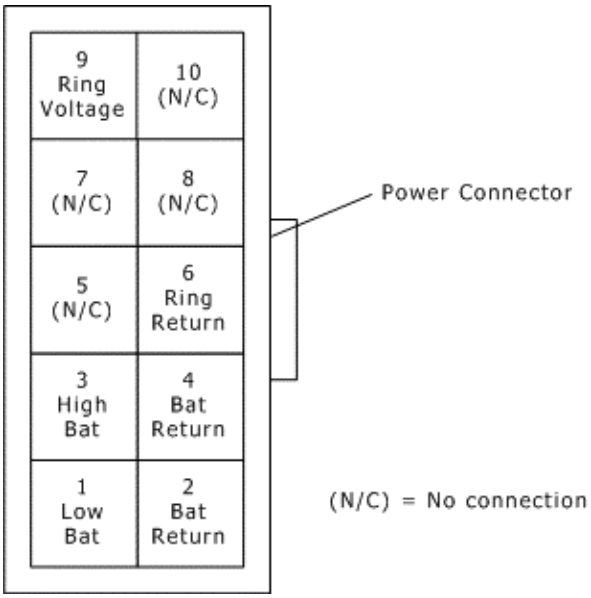

*Ring signal schematic (for CX 2000 power supply)*

## *Connecting an alternative power supply*

This section describes how to connect an alternative power supply directly to board, or to a telecom power bus.

### *Connecting directly to boards*

Connect the power supply to the TELCO POWER connector on the rear transition board. the following illustration shows the power connector pinouts for the CX 2000:




*Power connector pinouts*

The mating connector is Molex 43025-1000 with Molex 43030-0001 or Molex 43030-007 pins.

**Note:** If only one DC output is available, it must be connected to both the high battery input and the low battery input.

# Configuring the system

## Referencing the CDI manager for Natural Access

For the CDI manager component to be available to the Natural Access server when it boots, it must be referenced in your Natural Access configuration file, *cta.cfg*, as shown below:

```
[ctasys]
Service = ncc, adimgr
Service = adi, adimgr
Service = cdi, cdimgr
Service = ais, aismgr
Service = dtm, adimgr
Service = ppx, ppxmgr
Service = swi, swimgr
Service = vce, vcemgr
Service = oam, oammgr
```

For more information about *cta.cfg* and its contents, refer to the *Natural Access Developer's Reference Manual*.

## Adding board configurations to the NMS OAM database

For the NMS OAM software to be able to configure and start the boards, each board must have a separate set of configuration parameters and values in the NMS OAM database. Each parameter and value is expressed as a keyword name/value pair (for example, Encoding = MuLaw).

The following utilities shipped with NMS OAM allow you to set up the database:

| Utility | Description |
|---|---|
| *oamsys* | Performs system-wide configuration and startup of boards. Configures the NMS OAM database based on system configuration files you supply. Then attempts to start all boards listed in the database. |
| *oamcfg* | Provides greater access to individual NMS OAM configuration functions. |
| *oaminfo* | Displays keywords and settings for one or more components. Can also set individual keywords. |

**Note:** Applications can use OAM service functions to retrieve and modify configuration parameters. For more information, refer to the *NMS OAM Service Developer's Reference Manual*.

For general documentation of NMS OAM utilities, refer to the *NMS OAM System User's Manual*.

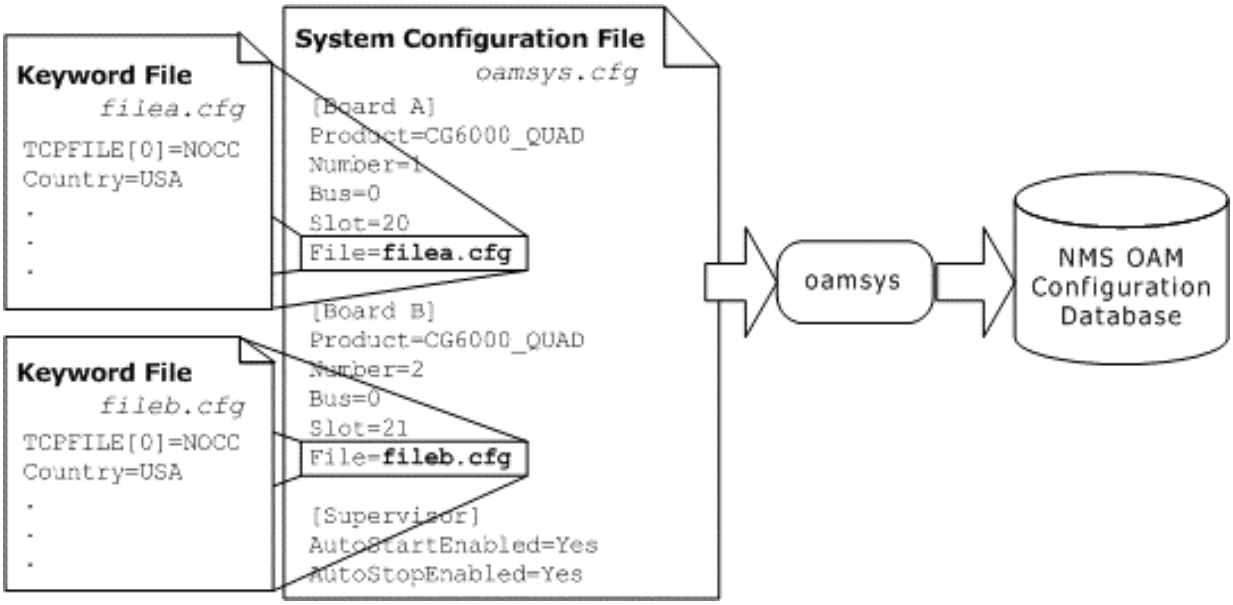
## Configuring the system using oamsys

To configure a system using the *oamsys* utility:

1. Install the boards as described in Installing the CX 2000 board.
2. Create a board keyword file for each board, containing keywords and values to configure the board.
3. Determine the PCI bus and slot locations of the boards, using the *pciscan* utility. For more information about *pciscan*, refer to the *NMS OAM System User's Manual*.
4. Create a system configuration file describing the overall board configuration. In this file, give each board a unique *name* and *board number*, and assign it a board keyword file.
5. Use *oamsys* to create records for your boards in the NMS OAM database based on the system configuration file, and to start all installed boards.

### *Using board keyword files*

A board keyword file contains a list of parameters and values to configure a board. The board keyword file for each board is assigned to the board in another file, called a system configuration file. When *oamsys* runs, it creates a record for each board in the NMS OAM database, and stores the parameters and values of the board. It then starts the board, configured as described in the database. (See the following illustration.)




*NMS OAM configuration files*

A sample board keyword file, *cx2000.cfg*, is installed by the CX 2000 software installation program. You can copy this file and modify it. The file is located in one of the following paths, depending upon your operating system:

| Operating system | Path to cx2000.cfg |
|---|---|
| Windows 2000 | *\nms\cx\cfg* |
| UNIX | */opt/nms/cx/cfg* |

You can customize additional features:

- Configure the ring cadence (see Configuring ring cadences)
- Specify the H.100 clock configuration (see Configuring board clocking)

The contents of *cx2000.cfg* are shown in the following example. For information on specific keywords, refer to Using keywords. For general information about NMS OAM board keyword files, refer to the *NMS OAM System User's Manual.*

```
  #
  #  Standalone operation
  #
Clocking.HBus.ClockMode   = STANDALONE
Clocking.HBus.ClockSource = OSC

  #
  #  Master the CT Bus (drive clock A)
  #
#Clocking.HBus.ClockMode   = MASTER_A
#Clocking.HBus.ClockSource = OSC

  #
  #  Slave to the CT Bus (slave from clock A)
  #
#Clocking.HBus.ClockMode   = SLAVE
#Clocking.HBus.ClockSource = A_CLOCK
```

## *Creating a system configuration file for oamsys*

When your board keyword file(s) are complete, create a *system configuration file* describing the overall configuration of your system, and assigning a board keyword file to each board. *oamsys* creates records in the NMS OAM database for your boards based on this file.

The system configuration file is typically named *oamsys.cfg*. By default, *oamsys* looks for a file with this name when it starts up.

Refer to the *NMS OAM System User's Manual* for specific information on the syntax and structure of this file.

The following chart describes the CX 2000 board-specific settings to include in the file for each board:

| Keyword | Description | Allowed values for CX 2000 products |
|---|---|---|
| [***name***] | The name of the board, used to refer to the board in software. The board name must be unique. | Any string, in square brackets []. |
| Product | The name of the board product. | CX 2000-16<br>CX 2000-32<br>CX_2000 |
| Number | The board number that your Natural Access application associates with the board. | Any integer from 0 to 31. Each board's number must be unique. |
| Bus | The PCI bus number. The bus:slot location for each board must be unique. | Values returned by *pciscan*. |
| Slot | The PCI slot number. The bus:slot location for each board must be unique. | Values returned by *pciscan*. |
| File | The name of the board keyword file containing settings for the board. | The name of the board keyword file you want to assign the board.<br>You can specify more than one file after the `File` keyword:<br>`File = mya.cfg myb.cfg myc.cfg`<br>Alternatively, you can specify the `File` keyword more than once:<br>`File = mya.cfg`<br>`File = myb.cfg`<br>`File = myc.cfg`<br>Board keyword files are sent in the order listed. The value for a given keyword in each file overrides any value specified for the keyword in earlier files. |

Keywords and values can also be specified directly in the system configuration file. This is often useful if your board configurations are identical, except for one or two parameters (such as clocking information).

### *Sample system configuration file*

The following sample system configuration file describes two CX 2000 boards:

- Board number 0 is located at bus 0, slot 15. It is assigned a keyword file named *cx-master.cfg*.
- Board number 1 is located at bus 0, slot 16. It is assigned a keyword file named *cx-slave.cfg*.

```
[CX-0]
Product = CX 2000-32
Number  = 0
Bus     = 0
Slot    = 15
File    = c:\nms\cx\cfg\cx-master.cfg


[CX-1]
Product = CX 2000-32
Number  = 1
Bus     = 0
Slot    = 16
File    = c:\nms\cx\cfg\cx-slave.cfg
```

### *Running oamsys*

To run *oamsys*, enter `oamsys` on the command line.

If you invoke *oamsys* without command line options, it searches for a file named *oamsys.cfg* in the paths specified in the AGLOAD environment variable.

When invoked with a valid filename, *oamsys* does the following:

- Checks the syntax of your system configuration file, and verifies that all required keywords are present.

**Note:** *oamsys* checks the syntax only on the system configuration file, and not on any board keyword files referenced in the system configuration file. *oamsys* reports all syntax errors it finds.

- Checks for uniqueness of board name, number, and bus/slot.
- Deletes all board configuration information currently stored in the NMS OAM database (if there is any).
- Sets up the NMS OAM database, and creates all records as described in the system configuration file.
- Attempts to start all boards, as described in the database.

**Note:** *ctdaemon* must be running for *oamsys* to operate. For more information about *ctdaemon*, refer to the *NMS OAM System User's Manual*.

## Changing configuration parameter settings

Once you have initialized the database with *oamsys*, you can make further parameter changes in any of the following ways:

- Modify the board keyword file for the board, make sure the name is correctly specified in the `File` statement in *oamsys.cfg*, and run *oamsys* again.
- Specify parameter settings using the *oamcfg* utility. For information about this utility, refer to the *NMS OAM System User's Manual*.
- Specify the settings using OAM service functions. (See the *NMS OAM Service Developer's Reference Manual* for more information.)

## Configuring ring cadences

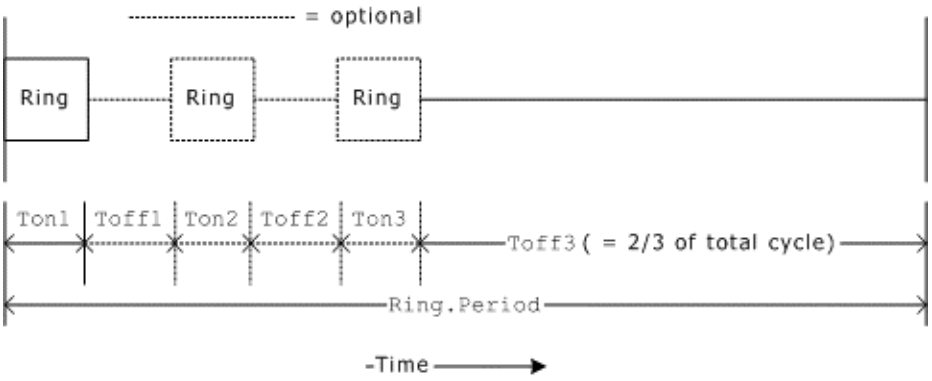
For a CX 2000 board, you can specify up to three different ring patterns (cadences) to be used at different times. For example, you can configure one cadence to signify an extension-to-extension call, another cadence to signify an outside call, and another cadence to signify a callback.

Each cadence can have up to three rings per cycle. For example, your first cadence could consist of one 2000 ms ring followed by 4000 ms of silence (like a typical ring tone in the United States). Your second cadence could sound more like the ring tone in the UK (ring ring...ring ring...). Your third cadence could have three rings (ring ring ring...ring ring ring...).

Ring cadencing is controlled using keywords. The cadencing keywords have default values that specify three distinctive ring cadences. The following keywords determine each cadence:

| Keyword | Description |
|---|---|
| Ring.Cadences[x].Ton1 | Determines the length (in ms) of the first ring in the cadence. |
| Ring.Cadences[x].Toff1 | Determines the length (in ms) of the silence between the first and second rings in the cadence. |
| Ring.Cadences[x].Ton2 | Determines the length (in ms) of the second ring in the cadence. |
| Ring.Cadences[x].Toff2 | Determines the length (in ms) of the silence between the second and last rings in the cadence. |
| Ring.Cadences[x].Ton3 | Determines the length (in ms) of the last ring in the cadence. |
| Ring.Cadences[x].Toff3 | Determines the length (in ms) of the silence between the last ring in the cadence and the first ring of the next cadence. This value must be equal to 2/3 of the total length of the cadence. |
| Ring.Period | Must be set to the total length of the cadence (in ms). |

The following illustration illustrates the role of each keyword in determining a cadence:




*Cadence components*

You can omit the third ring, or both the second and third rings, by setting their keywords to 0. However, Ring.Cadences[x].Ton1 and Ring.Cadences[x].Toff3 must always be set. Also, Ring.Cadences[x].Toff3 must always equal at least 2/3 of the total length of the cadence. This is so the ring phasing algorithm works correctly.

All cadences must be of the same length; that is, the total of

```
  Ring.Cadences[x].Ton1
+ Ring.Cadences[x].Toff1
+ Ring.Cadences[x].Ton2
+ Ring.Cadences[x].Toff2
+ Ring.Cadences[x].Ton3
+ Ring.Cadences[x].Toff3
```

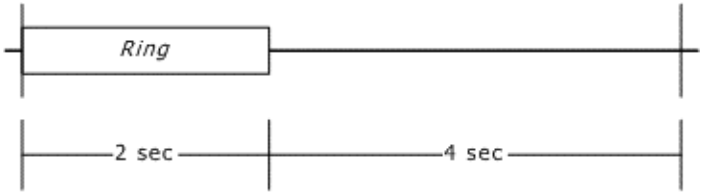
... must be the same for each cadence. Set the Ring.Period keyword to this length.

## Default ring cadences

The cadencing keywords have default values that specify three distinctive ring cadences. The following table lists the default values for the keywords:

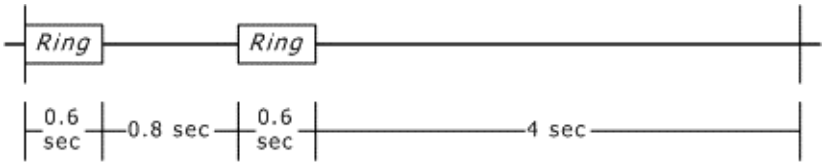
| x | Ton1 | Toff1 | Ton2 | Toff2 | Ton3 | Toff3 | Total ms | Ring pattern |
|---|---|---|---|---|---|---|---|---|
| 0 | 2000 | 0 | 0 | 0 | 0 | 4000 | 6000 | ring...(silence)... |
| 1 | 600 | 800 | 600 | 0 | 0 | 4000 | 6000 | ring...ring...(silence)... |
| 2 | 400 | 400 | 400 | 400 | 400 | 4000 | 6000 | ring...ring...ring...(silence)... |

The following illustration, the following illustration, and the following illustration illustrate the three default cadences:



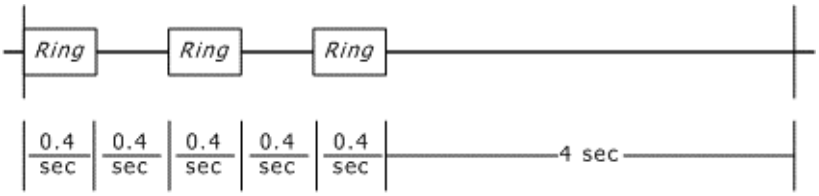

```
Ring.Cadences[0].Ton1  =    2000
Ring.Cadences[0].Toff1 =    0
Ring.Cadences[0].Ton2  =    0
Ring.Cadences[0].Toff2  =   0
Ring.Cadences[0].Ton3  =    0
Ring.Cadences[0].Toff3  =   4000
                   -------
      Ring.Period =  6000
```

*Default cadence (x=0)*




```
Ring.Cadences[1].Ton1  =  600
Ring.Cadences[1].Toff1 =  800
Ring.Cadences[1].Ton2  =  600
Ring.Cadences[1].Toff2   = 0
Ring.Cadences[1].Ton3  =  0
Ring.Cadences[1].Toff3   = 4000
                   -------
      Ring.Period =6000
```

*Default cadence (x=1)*




```
Ring.Cadences[2].Ton1  =     400
Ring.Cadences[2].Toff1 =     400
Ring.Cadences[2].Ton2  =     400
Ring.Cadences[2].Toff2  =    400
Ring.Cadences[2].Ton3  =     400
Ring.Cadences[2].Toff3  =    4000
                    -------
      Ring.Period =  6000
```

*Default cadence (x=2)*

# Configuring board clocking

When multiple boards are connected to the CT bus, you must set up a bus clock to synchronize timing between them. In addition, you can configure alternative (fallback) clock sources to provide the clock signal if the primary source fails.

This topic describes:

- CT bus clocking.
- The clocking capabilities of CX 2000 and CX 2000C boards.
- How CX 2000 clocking differs from other boards.
- How to configure clocking in a system using keywords.
- Examples of CX 2000 clocking.

To create a robust clocking configuration, you must understand basic clocking concepts such as clock mastering and fallback. For a complete overview of board clocking, refer to the *NMS OAM System User's Manual*.

## *CT bus clocking overview*

This section provides a generalized discussion of CT bus clocking.

**Note:** The CX 2000 board does not implement all of the aspects of clocking described here. Refer to Clocking capabilities to learn the capabilities which apply to these boards.

Boards in a CT bus system can be configured in any of the following modes:

| Board mode | Description |
|---|---|
| Primary clock master | Drives the primary timing reference for boards connected to the CT bus. It can switch between two specified timing sources in order to maintain the primary timing reference. |
| Secondary clock master | Drives the secondary timing reference. If both of the primary clock master's timing references fail, the secondary master continues to drive a secondary clock using a clock fallback source as its timing reference. |
| Clock slave | References its timing from the primary clock master. Can use the secondary clock master as a fallback source of clock timing. |
| Standalone | Does not reference the primary or secondary master, and consequently cannot make switch connections to the CT bus. |

Boards that act as clock slaves derive their timing from signals driven by the clock masters (primary or secondary). Clock masters can drive either of two clocks, A_CLOCK or B_CLOCK.

Certain board models have more flexible and reliable clocking capabilities than other models. In a mixed board system, choose the boards with the best capabilities as your primary and secondary masters. To determine which boards to use as masters, refer to the *NMS OAM System User's Manual*.

### *Timing references*

Clock masters (primary or secondary) can synchronize their own timing signals from the following sources:

| Timing reference source | Description |
|---|---|
| NETWORK | A signal originating within the public network, and entering the system through a digital trunk. |
| NETREF | A clock signal broadcast on the bus by another device, which can be used by a clock master as a timing reference from which to synchronize A_CLOCK or B_CLOCK. |
| NETREF2 | H.110 only |
| OSC | A signal originating from a board's oscillator. |

For details on configuring bus clocks, refer to the *NMS OAM System User's Manual* or the *ECTF H.110 Hardware Compatibility Specification: CT Bus R1.0*.

### *Clock fallback*

The CT bus supports a system of clock fallback that allows the system to use alternate timing references when one or more sources fail.

To enable clock fallback, set Clocking.HBus.AutoFallBack = YES. If clock fallback is disabled, the application must perform all clocking changes.

To implement clock fallback:

1. Configure a primary clock master to drive the CT bus clock (A clock or B clock) based on a network timing reference. All slave boards will synchronize their timing through this clock.
2. Configure a secondary clock master to use the signal from the primary clock to drive the alternate CT bus clock (in other words, if the primary master drives A_CLOCK, configure the secondary master to drive B_CLOCK based on A_CLOCK, or vice versa).
3. Specify a fallback network timing reference for the secondary clock master to use in the event the primary clock master fails.
4. Configure all slave boards to specify the secondary clock master as their clock fallback source.
5. When the boards are configured in this way, the secondary clock master continues to drive the secondary clock (based on its own network timing reference) if the primary clock master fails. Slave boards within the system fall back to synchronize their timing from the secondary clock master.

**Note:** CT bus clock fallback establishes a redundant system of timing references for the CT bus. It does not create an autonomous clock timing environment. When clock fallback occurs, you must intervene to reset system clocking before the all of the specified fallback timing references are exhausted. If all of the timing references specified for the primary and secondary clock masters fail (and no intervention takes place), boards on the system default to standalone mode.

## *Clocking capabilities*

CX 2000 boards do not have any direct access to an external source to derive a timing reference. Thus the NETWORK timing reference is not directly available to these boards. The only timing source available to CX 2000 boards is OSC.

**Note:** It is also possible to configure a CX 2000 board to use NETREF as a timing reference. However, a simpler solution is to have the board driving NETREF serve as the clock master instead, and eliminate use of these signals altogether.

If another board has access to an outside clock signal, use this board as the clock master. CX 2000 boards are best used as clock masters only if none of the boards on the H.100 bus have any access to an outside digital clock signal (for example, if your system contains only boards with analog trunk interfaces). In this case, the CX 2000 board can drive A_CLOCK or B_CLOCK using its internal oscillator (OSC) as the timing reference.

## CX 2000 clocking exceptions

CX 2000 clocking differs from other boards in the following ways.

There are four watchdogs in the T8100A: A_CLOCK, B_CLOCK, NR1, and NR2. All of the watchdogs are cleared by a single bit in a command register. In a fallback situation, clearing the watchdogs results in reverting to the original clock source. When fallback is enabled and the watchdog for the primary clock source triggers, the CX 2000 latches current and future watchdog errors until the next MVIP95_CMD_CONFIG_BOARD_CLOCK command is received. This command can be issued directly to the switching driver or indirectly by the OAM clock manager's apply keyword.

If, for example, A_CLOCK failed and a slaving CX 2000 falls back to B_CLOCK, and if B_CLOCK were to go bad momentarily and recover, the CX 2000 would latch both clocks as bad until the board is reconfigured even though B_CLOCK recovered.

If no clock sources are available to a SLAVE-mode CX 2000, the on-board DSP will stall and calls may be dropped. Normal operation will resume with the resumption of system clock.

## Configuring CT bus clocks with keywords

The CX 2000 board keywords allow you to configure the board in the following ways:

- System primary clock master
- System secondary clock master
- Clock slave
- Standalone board
- You can also use board keywords to establish clock fallback sources.

The following sections describe how to use board keywords to specify clocking configurations on multiple-board or multiple-chassis systems.

To configure clocking, set the following keywords for each board:

| Keyword | Description |
|---|---|
| Clocking.HBus.ClockSource | Specifies the source from which a board derives its timing. |
| Clocking.HBus.ClockMode | Specifies the CT bus clock mode for the board (for example, A_CLOCK master, B_CLOCK master, slave or standalone). |
| Clocking.HBus.AutoFallBack | Enables or disables clock fallback on the board. |
| Clocking.HBus.FallbackClockSource | Specifies an alternate clock reference to use when the primary clock source fails. |

### *Configuring the primary clock master*

Use the following keyword settings to configure a CX 2000 board as the primary clock master:

**Note:** A CX 2000 should not be used as primary or secondary clock master unless no board in the system has access to an external timing reference.

| Keyword | CX board setting |
|---|---|
| Clocking.HBus.ClockSource | OSC<br>You can also set this keyword to NETREF. However, you should use these settings only if another board has access to an external timing reference, and the CX board must act as clock master. This configuration is not recommended. |
| Clocking.HBus.ClockMode | MASTER_A or MASTER_B |
| Clocking.HBus.AutoFallBack | YES if Clocking.HBus.ClockSource is set to NETREF. Otherwise, set to NO. |
| Clocking.HBus.FallbackClockSource | A timing reference other than the one specified with Clocking.HBus.ClockSource: NETREF or OSC. |

### *Configuring the secondary clock master*

Use the following keyword settings to configure a CX 2000 board as the secondary clock master:

**Note:** A CX 2000 should not be used as primary or secondary clock master unless no board in the system has access to an external timing reference.

| Keyword | CX board setting |
|---|---|
| Clocking.HBus.ClockSource | The bus clock driven by the primary master: A_CLOCK or B_CLOCK. |
| Clocking.HBus.ClockMode | The bus clock not driven by the primary master (for example, MASTER_B if the primary master is set to MASTER_A). |
| Clocking.HBus.AutoFallBack | YES |
| Clocking.HBus.FallbackClockSource | Any timing reference not used by the primary clock master: NETREF or OSC. |

### *Configuring clock slaves*

Use the following keyword settings to configure a CX 2000 board as a clock slave:

| Keyword | CX board setting |
|---|---|
| Clocking.HBus.ClockMode | SLAVE to indicate that the board does not drive any CT bus clock. |
| Clocking.HBus.ClockSource | A_CLOCK or B_CLOCK. |
| Clocking.HBus.AutoFallBack | YES |
| Clocking.HBus.FallbackClockSource | Set to the bus clock driven by the secondary master (A_CLOCK or B_CLOCK. |

### *Configuring standalone boards*

To configure a board in standalone mode so the board references its own clocking information, set Clocking.HBus.ClockMode to STANDALONE. In standalone mode, the board uses its own oscillator as its timing signal reference. However, the board cannot make switch connections to the CT bus. Switching commands involving CT bus streams will return an error.

## Examples

### Example 1: System with CX 2000 or CX 2000C and AG 4000s or AG 4000Cs as masters

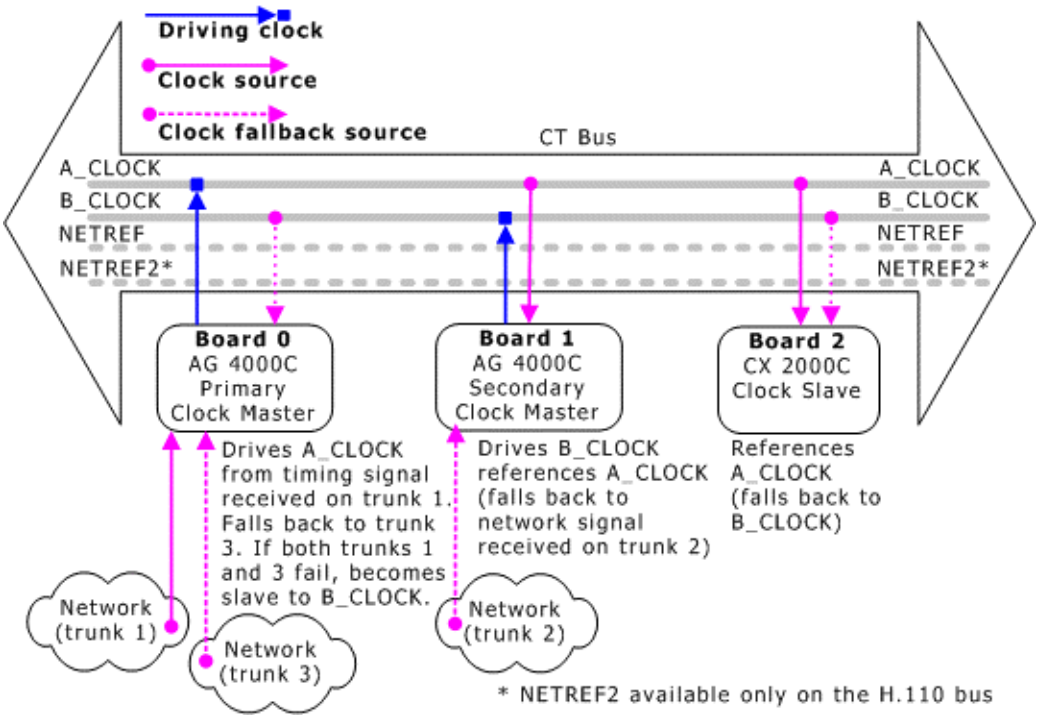
The following example assumes a system configuration where one CX 2000 or CX 2000C board and two AG 4000 or AG 4000C boards reside on a single chassis. The boards are configured in the following way:

| Board | Configuration |
|---|---|
| Board 0 | AG 4000 or AG 4000C board. Primary bus master. Drives A_CLOCK, based on signal from network (trunk 1). Falls back to signal from network (trunk 3). |
| Board 1 | AG 4000 or AG 4000C board. Secondary bus master. Drives B_CLOCK, based on signal from A_CLOCK. Falls back to signal from network (trunk 2). |
| Board 2 | CX 2000 or CX 2000C board. Clock slave to A_CLOCK (auto-fallback enabled). |

This configuration assigns the following clocking priorities:

| Priority | Timing reference |
|---|---|
| First | Board 0, digital trunk 1.<br>A network signal from a digital trunk provides the primary master clock source. |
| Second | Board 0, digital trunk 3.<br>A network signal from a digital trunk provides the primary master clock source. |
| Third | Board 1, digital trunk 2.<br>A network signal from a digital trunk provides the secondary master clock fallback source. |

The following illustration illustrates this configuration:




*Sample board clocking configuration*

The following table shows keywords used to configure the boards according to the configuration shown in the following illustration.

| Board | Role | Clocking keyword settings |
|---|---|---|
| 0 | Primary clock master | Clocking.HBus.ClockMode = MASTER_A<br>Clocking.HBus.ClockSource = NETWORK<br>Clocking.HBus.ClockSourceNetwork = 1<br>Clocking.HBus.AutoFallBack = YES<br>Clocking.HBus.FallBackClockSource = NETWORK<br>Clocking.HBus.FallBackNetwork = 3 |
| 1 | Secondary clock master | Clocking.HBus.ClockMode = MASTER_B<br>Clocking.HBus.ClockSource = A_CLOCK<br>Clocking.HBus.AutoFallBack = YES<br>Clocking.HBus.FallBackClockSource = NETWORK<br>Clocking.HBus.FallBackNetwork = 2 |
| 2 | Clock slave | Clocking.HBus.ClockMode = SLAVE<br>Clocking.HBus.ClockSource = A_CLOCK<br>Clocking.HBus.AutoFallBack = YES<br>Clocking.HBus.FallBackClockSource = B_CLOCK |

In this configuration, Board 0 is the primary clock master and drives A_CLOCK. All slave boards on the system use A_CLOCK as their first timing reference. Board 0 references its timing from a network timing signal received on its own trunk 1. Board 0 also uses the network timing signal from its own trunk 3 as its clock fallback source. This means that if the network timing signal derived from its own digital trunks fails, Board 0 will continue to drive A_CLOCK based on the timing reference from trunk 3.

If, however, both of the signals used by Board 0 fail, Board 0 stops driving A_CLOCK. The secondary master (Board 1) then falls back to a timing reference received on its own trunk 2, and uses this signal to drive B_CLOCK. B_CLOCK then becomes the timing source for all boards that use B_CLOCK as their backup timing reference. The primary master also attempts to slave to B_CLOCK.

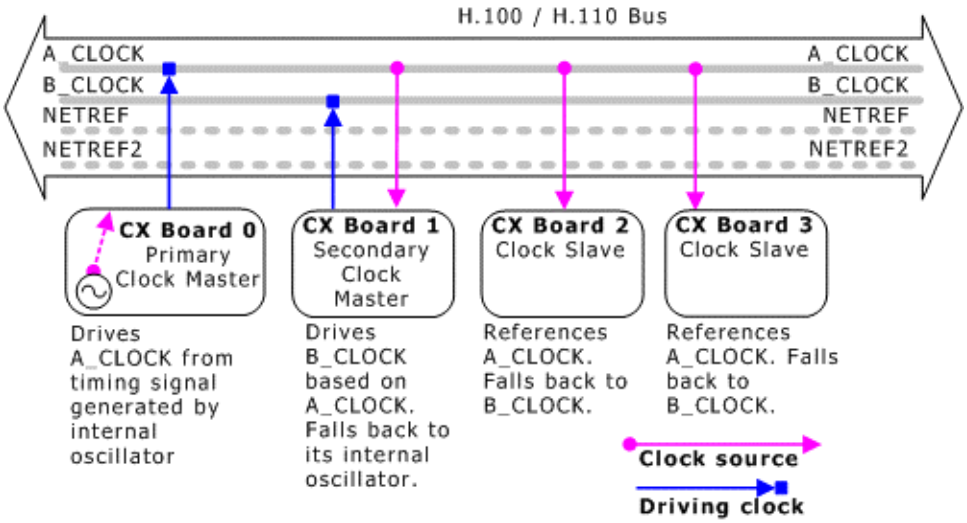
**Note:** For this to take effect, all the clock slaves must specify A_CLOCK as their clock source, and B_CLOCK as their clock fallback source.

### *Example 2: System with CX 2000 or CX 2000C boards only, CX is master*

The following example assumes a system configuration where four CX 2000 or CX 2000C boards reside on a single chassis. The boards are configured in the following way:

| Board | Configuration |
|---|---|
| Board 0 | Primary clock master. Drives A_CLOCK, based on signal from internal oscillator. Auto-fallback disabled. |
| Board 1 | Secondary clock master. Drives B_CLOCK, based on signal from A_CLOCK. Falls back to its internal oscillator. |
| Board 2 | Clock slave to A_CLOCK. Falls back to B_CLOCK. |
| Board 3 | Clock slave to A_CLOCK. Falls back to B_CLOCK. |

The following illustration illustrates this configuration:




*Sample board clocking configuration*

The following table shows keywords used to configure the boards according to the configuration shown in the following illustration.

| Board | Role | Clocking keyword settings |
|---|---|---|
| 0 | Primary clock master | Clocking.HBus.ClockMode = MASTER_A<br>Clocking.HBus.ClockSource = OSC<br>Clocking.HBus.AutoFallBack = NO |
| 1 | Secondary clock master | Clocking.HBus.ClockMode = MASTER_B<br>Clocking.HBus.ClockSource = A_CLOCK<br>Clocking.HBus.AutoFallBack = YES<br>Clocking.HBus.FallBackClockSource = OSC |
| 2 | Clock slave | Clocking.HBus.ClockMode = SLAVE<br>Clocking.HBus.ClockSource = A_CLOCK<br>Clocking.HBus.AutoFallBack = YES<br>Clocking.HBus.FallBackClockSource = B_CLOCK |
| 3 | Clock slave | Clocking.HBus.ClockMode = SLAVE<br>Clocking.HBus.ClockSource = A_CLOCK<br>Clocking.HBus.AutoFallBack = YES<br>Clocking.HBus.FallBackClockSource = B_CLOCK |

In this configuration, Board 0 is the primary master and drives A_CLOCK. All slave boards on the system use A_CLOCK as their first timing reference. Board 0 references its timing from a signal derived from its oscillator. Auto-fallback is disabled for this board.

Board 1 is the secondary master, driving B_CLOCK based on A_CLOCK. If board 0 stops driving A_CLOCK, board 1 continues driving B_CLOCK based upon its internal oscillator.

All other boards are slaves to A_CLOCK. If Board 0 stops driving the clock, all boards fall back to B_CLOCK, which is driven by board 1. If board 1 stops driving B_CLOCK, all boards fall back to their internal oscillators.

## Notes on modem connections

The CX 2000 board interface can provide the same grade of connection to high-speed modems (such as V.34 and V.90) as PBXs and telephone office switches. However, the speed of the connections is not guaranteed to be at the highest rates. The following system factors are important in obtaining optimum modem performance:

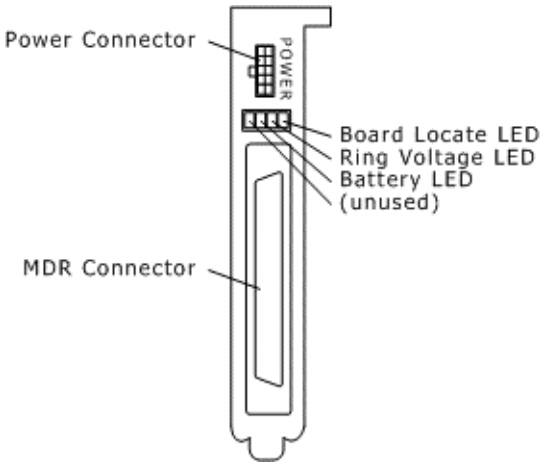
- Cables from the board to the modem must be short, telephone grade twisted pair. Avoid routing cables near noise sources. Avoid moisture in cables.
- There should be only one 2-wire analog loop connection from the modem to the ISP. Also, there should be at most one analog-to-digital conversion in the link from the modem to the ISP. Digital trunks to the public network are preferred for V.34 and are required by V.90 technology.
- Add loss in the uplink connection to speed up the downlink connection if analog trunks are used. This reduces the echo signal.

**Note:** Even with these precautions, network impairments such as noise, echo, or distortion can continue to limit modem performance, causing slower transfer speeds than desired. These are limitations of the network and modem technologies.

# Verifying the installation

## CX 2000 status indicator LEDs

The CX 2000 has LEDs located on its rear bracket (see the following illustration):




*CX 2000 LEDs*

The following table describes each LED:

| LED | Description |
|---|---|
| Board Locate | Locates a board using *pciscan*. |
| Ring Voltage | LED on verifies that a ring signal is available to the board. |
| Battery | LED on verifies -24 V DC is available to the board. |

The fourth LED is not used. It is on when the battery LED is on.

**Note:** Even with these precautions, network impairments such as noise, echo, or distortion can continue to limit modem performance, causing slower transfer speeds than desired. These are limitations of the network and modem technologies.

## Verifying the board installation

To verify that you have installed a CX 2000 board correctly:

1. Install the hardware, as described in Installing the CX 2000 board. For simplicity, ensure that no other telephony boards are driving bus clocks.
2. Install the software. Refer to the Natural Access installation booklet for more information.
3. Connect the power supply to the rear power connector as explained in Using the NMS rack mount power supply chassis.
4. Run *pciscan* to locate the CX 2000 hardware on the PCI bus. To run *pciscan*, enter `pciscan`.
    a. *pciscan* displays information on the boards that are configured in the system, including the Bus and Slot values.
    b. You can identify individual boards by flashing an LED on the front panel or end bracket. The Board Locate LED flashes. To flash an LED, invoke *pciscan* with a specific bus and slot (for example, `pciscan 2 14`).
    c. The LED begins flashing. Press any key to stop flashing. For more information about *pciscan*, refer to *NMS OAM System User's Manual*.
5. Edit your system configuration file to reflect the PCI settings. For information about this file, refer to Configuring the system using oamsys.
6. Configure the target board to operate in standalone mode by driving clocks with the internal oscillator. To do so, add the following keyword statements to the board's keyword file:

```
Clocking.HBus.ClockMode = STANDALONE
Clocking.HBus.ClockSource = OSC
SwitchConnections = Auto
```

7. Attach a telephone to the port for station number 1. (Port numbering is 1-based; timeslot numbering is 0-based. To determine the timeslot for a port, subtract 1 from the port number.)

    For more information on attaching telephones to the board, refer to Connecting to station phones.
8. Run the *oammon* utility. This utility monitors for board errors or other events.
9. Run *oamsys* to boot the board. *oamsys* interprets the system configuration file and loads the parameters in the keyword files to the boards. *oamsys* searches for configuration files in the AGLOAD path.

    To run *oamsys*, open a command window and enter `oamsys`.

    For more information about *oamsys* and *pciscan*, refer to the *NMS OAM System User's Manual*.
10. Examine the *oammon* output for errors and other events.

## Verifying the board's operation

Once you have verified that the board is properly installed (as described in Verifying the board installation), use the *cditest* utility to check that the board is operating correctly. Using *cditest* and a telephone, you can see off-hook/on-hook events, play dial tone, see DTMF events, ring the telephone and more.

For more information about *cditest*, see Using CX demonstration programs.

Follow this procedure to perform a simple board operation test:

1. Set up the board, and verify that it is working correctly in standalone mode as described in Verifying the board installation.
2. Run the *cditest* utility. *cditest* can be found in one of these directories:

| Operating system | Path |
|---|---|
| Windows 2000 | *\nms\ctaccess\demos\cditest* |
| UNIX | */opt/nms/ctaccess/demos/cditest* |

On the *cditest* command line, specify the address of the DSP port corresponding to the attached telephone's line interface port. For example, if the telephone is attached to port 1 (timeslot 0) on board 0, and the DSP is attached to stream 4, run *cditest* by entering: `cditest -b 0 -s 4:0`

3. When you run *cditest*, *cditest* displays a command prompt.
4. Enter the following commands at the prompt:
   a. Type `op` to open the port.
   b. Type `et` to enable talk battery power.
   c. Type `eb` to start the signaling detector.
   d. Take the phone off-hook. The event CDIEVN_OFF_HOOK is displayed.
   e. Type `ed` to start the DTMF detector.
   f. Type `gn`, and press the **Return** key to generate a dial tone.

   Dial digits on the telephone. As you do so, digit events are displayed as follows:

```
Event: CDIEVN_DTMF_STARTED, digit 1
Event: CDIEVN_DTMF_ENDED
Event: CDIEVN_DTMF_STARTED, digit 2
Event: CDIEVN_DTMF_ENDED
Event: CDIEVN_DTMF_STARTED, digit 3
Event: CDIEVN_DTMF_ENDED
```

6. Place the phone on-hook. The event CDIEVN_ON_HOOK is displayed.
7. Type `sr` to start ringing the phone. The phone rings.
8. Type `ar` to stop ringing the phone.
9. Type `cp` to close the port.
10. Type `q` to quit `cditest`.

## Verifying the board's operating temperature

The CX Devices Interface (CDI) service (described in CDI service) provides API functions for temperature monitoring on CX 2000 boards. Refer to the *CDI Service Developer's Reference Manual* for more information about these functions.

Readings should be taken after running under a typical load (with a number of stations off-hook) for one hour. The following table indicates the maximum safe operating temperatures for various environments:

| On-board temperature sensor ID | Maximum temperature reading in temperature controlled laboratory environment | Maximum field operating temperature |
|---|---|---|
| 0 | 65° C | 90° C |
| 1 | 65° C | 90° C |
| 2 | 60° C | 90° C |
| 3 | 60° C | 90° C |
| 4 | 60° C | 90° C |

Exceeding these readings will cause warnings of overheating. You must reduce the temperature in one of the following ways:

- Clean the chassis air filters.
- Replace a failed or underrated fan.
- Replace the chassis with one that provides more air flow. For chassis recommendations for CX 2000 boards, refer to Selecting a PCI chassis.
- Improve room temperature controls.

Any CX 2000 board operating beyond the maximum field operating temperatures may exhibit one or more of the following symptoms:

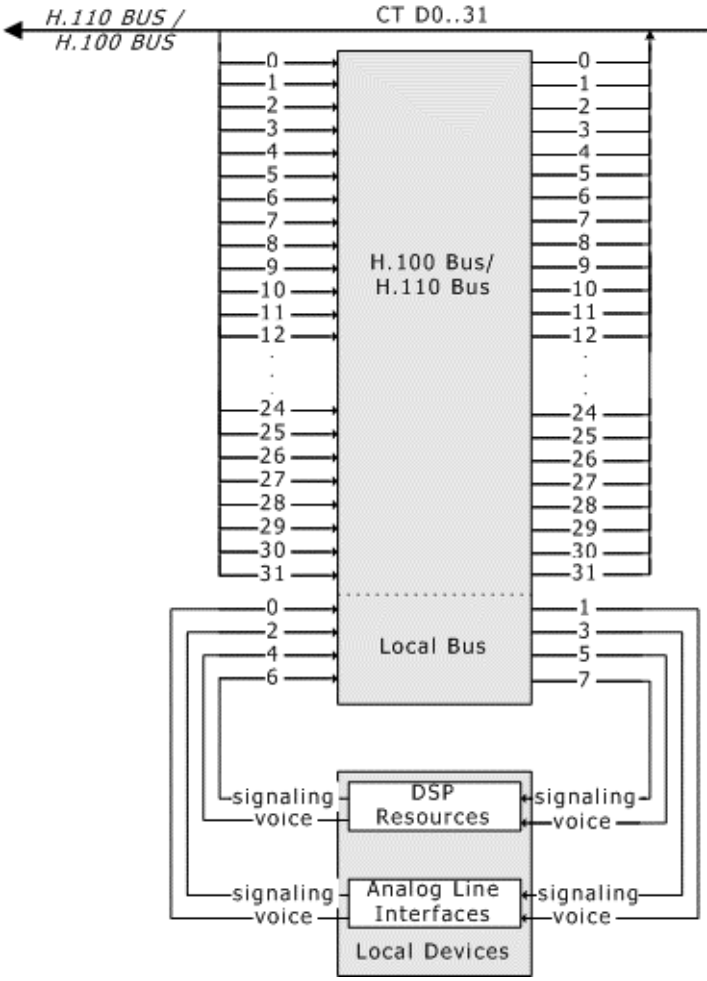
- Events are sent to the application warning of overheating. For more information about these events, refer to the *CDI Service Developer's Reference Manual*.
- New calls will receive a strange tone in place of the dial tone.
- The loop current may be reduced. This reduction in current may impact the operation of telephones or other attached devices.

# Implementing switching

## CX 2000 board switch model

The following illustration shows the CX 2000 and CX 2000C board switch model using the H.100 bus. The H.100 bus information for the CX 2000 board is the same as the CX2000C, except where noted. The specific use of each stream is as follows:

| **H.110/H.100 streams** | |
|---|---|
| H.110 and H.100 Bus | Streams 0..31, timeslots 0..127 (Streams clocked at 8 MHz) |
| Local streams | |
| Station Voice Information | Stations 0 - 47: Streams 0 and 1, timeslots 0..47 for 48 ports<br>Stations 0 - 31: Streams 0 and 1, timeslots 0..31 for 32 ports |
| Station Signaling Information | Stations 0 - 47: Streams 2 and 3, timeslots 0..47 for 48 ports<br>Stations 0 - 31: Streams 2 and 3, timeslots 0..31 for 32 ports |
| DSP Voice Information | Streams 4 and 5, timeslots 0..47 for 48 ports<br>Streams 4 and 5, timeslots 0..31 for 32 ports |
| DSP Signaling Information | Streams 6 and 7, timeslots 0..47 for 48 ports<br>Streams 6 and 7, timeslots 0..31 for 32 ports |




*CX 2000 / CX 2000C board switch model*

## *Lucent T8100A switch blocking*

The CX 2000 and CX 2000C board switching is implemented by the Lucent T8100A chip (HMIC). The Lucent T8100A can perform local bus to local bus switching in full non-blocking fashion.

The number of H.110 or H.100 connections is limited to a maximum of 128 full duplex or 256 simplex (or half duplex) connections, in any combination, from either the

- H.110 bus to the local bus, or
- H.110 bus to H.110 bus

## Default connections for a standalone board

For a standalone CX 2000 board, disable H.100 connectivity in the configuration file (Clocking.HBus.ClockMode = DISABLE). In this case, default connections are made on the board to connect the voice and signaling information to DSP resources.

| Station Type | Setting |
|---|---|
| Full Duplex Voice Station | Local:0:0..47 => Local:5:0..47, Local:4:0..47 => Local:1:0..47 for 48 ports<br>Local:0:0..31 => Local:5:0..31, Local:4:0..31 => Local:1:0..31 for 32 ports |
| Full Duplex Signaling Station | Local:2:0..47 => Local:7:0..47, Local:6:0..47 => Local:3:0..47 for 48 ports<br>Local:2:0..31 => Local:7:0..31, Local:6:0..31 => Local:3:0..31 for 32 ports |

## Using the switching service

To use the Natural Access Switching service (SWI) with CX 2000 boards, applications must create a context and open the switching service on that context. Since switching is a board-level function, applications typically open the switching service on a non-DSP port, such as 0:0.

Refer to the *Natural Access Developer's Reference Manual* and the *Switching Service Developer's Reference Manual* for additional information and examples of opening services.

### *Opening the switch*

After opening the switching service, applications can open the switch block on the board to obtain a switch handle for further switching service calls. To open the switch block on a board, specify the switching driver name in the call to **swiOpenSwitch**. For CX 2000 boards, the driver name is *cxsw*. The following example shows how to use *cxsw* in an application:

```
//Open the switchblock for the board using the proper driver
dwRetValue = swiOpenSwitch(hContext,
                           "cxsw",
                           BoardNumber,
                           0x0,
                           &hSwitch);
```

### *Configuring local devices*

Local device configuration on CX 2000 boards is controlled by the Switching service. The Switching service provides generic API functions for accessing device configuration parameters defined by the underlying hardware and device driver.

Applications can use **swiConfigLocalTimeslot** and **swiGetLocalTimeslotInfo** to configure a device on a given local stream and timeslot by specifying a particular parameter and providing a data structure specific to that parameter. For more information about these functions, refer to the *Switching Service Developer's Reference Manual*.

# Accessing the line gain

CX 2000 boards support input and output gain configurations on network voice ports (timeslots) from -6 dB to +6 dB in one dB increments.

*Input gain* is applied to the signal received from the network. *Output gain* is applied to the signal transmitted to the network. The default value for both input line gain and output line gain on CX 2000 boards is nominally 0 dB.

| | |
|---|---|
| ***Caution:*** | *Increasing gain may also increase noise, echo, degrade DTMF detection, and possibly cause oscillations on the telephone network. There also may be regulatory authority implications. Use gain with caution.* |

Decreasing gain may reduce echo and other noise.

This topic describes:

- Getting the line gain
- Setting the line gain

## *Getting the line gain*

Use **swiGetLocalTimeslotInfo** to query the input or output line gain. Set the arguments to this function as follows:

| Argument | Field | Value |
|---|---|---|
| ***swihd*** | | Handle returned by **swiOpenSwitch**. |
| ***args*** | localstream | `0` or `1`. Refer to the switch model presented in CX 2000 board switch model. |
| | localtimeslot | `0..47`. Refer to the switch model presented in CX 2000 board switch model. |
| | deviceid | MVIP95_ANALOG_LINE_DEVICE |
| | parameterid | MVIP95_INPUT_GAIN or MVIP95_OUTPUT_GAIN |
| ***buffer*** | | Points to the NMS_LINE_GAIN_PARMS structure. Refer to the structure presented in this section. |
| ***size*** | | Size of buffer, in bytes. |

The NMS_LINE_GAIN_PARMS structure is

```
typedef struct
{
     INT32 gain;

} NMS_LINE_GAIN_PARMS;
```

The value returned in the gain component of NMS_LINE_GAIN_PARMS is the gain in dB multiplied by 1000. For example, if the input gain on a particular network timeslot is currently set to -3 dB, after calling **swiGetLocalTimeslotInfo** for parameter MVIP95_INPUT_GAIN, the gain field is -3000.

The following sample code shows how to retrieve line gain applied to a signal received from the network:

```
#include "swidef.h"  /*  Natural Access Switching service          */
#include "mvip95.h"  /*  MVIP-95 definitions                       */
#include "nmshw.h"   /*  NMS hardware-specific definitions         */

DWORD myGetReceiveGain ( SWIHD swihd, SWI_TERMINUS terminus, INT32*
                                                          gain_dB )
{
     SWI_LOCALTIMESLOT_ARGS  args;
     NMS_LINE_GAIN_PARMS     device ;
     DWORD                   rc ;

     args.localstream      = terminus.stream ;
     args.localtimeslot    = terminus.timeslot ;
     args.deviceid         = MVIP95_ANALOG_LINE_DEVICE ;
     args.parameterid      = MVIP95_INPUT_GAIN ;

     rc = swiGetLocalTimeslotInfo(
            swihd,            /* Natural Access switch handle       */
            & args,           /* target device and config item      */
            (void*) & device, /* buffer (defined by parameterid)    */
            sizeof(device));  /* buffer size in bytes               */

    *gain_dB  =  device.gain / 1000  ;

     return rc ;
}
```

The following sample code shows how to retrieve line gain applied to a signal transmitted to the network:

```
#include "swidef.h"  /*  Natural Access Switching service          */
#include "mvip95.h"  /*  MVIP-95 definitions                       */
#include "nmshw.h"   /*  NMS hardware-specific definitions         */

DWORD myGetTransmitGain ( SWIHD swihd, SWI_TERMINUS terminus,
                                                 INT32* gain_dB )
{
     SWI_LOCALTIMESLOT_ARGS  args;
     NMS_LINE_GAIN_PARMS     device ;
     DWORD                   rc ;

     args.localstream      = terminus.stream ;
     args.localtimeslot    = terminus.timeslot ;
     args.deviceid         = MVIP95_ANALOG_LINE_DEVICE ;
     args.parameterid      = MVIP95_OUTPUT_GAIN ;


     rc = swiGetLocalTimeslotInfo(
            swihd,            /* Natural Access switch handle       */
            & args,           /* target device and config item      */
            (void*) & device, /* buffer (defined by parameterid)    */
            sizeof(device));  /* buffer size in bytes               */

    *gain_dB  =  device.gain / 1000  ;

     return rc ;

}
```

## Setting the line gain

Use **swiConfigLocalTimeslot** to set the input or output line gain. Set the arguments to this function as follows:

| Argument | Field | Value |
|---|---|---|
| ***swihd*** | | Handle returned by **swiOpenSwitch**. |
| ***args*** | localstream | 0 or 1. Refer to the switch model presented in CX 2000 board switch model. |
| | localtimeslot | 0..47 (maximum 31 in 32 station models). Refer to the switch model presented in CX 2000 board switch model. |
| | deviceid | MVIP95_ANALOG_LINE_DEVICE |
| | parameterid | MVIP95_INPUT_GAIN or MVIP95_OUTPUT_GAIN |
| ***buffer*** | | Points to the NMS_LINE_GAIN_PARMS structure. Refer to the structure below. |
| ***size*** | | Size of buffer, in bytes. |

The NMS_LINE_GAIN_PARMS structure is

```
typedef struct
{
     INT32 gain;

} NMS_LINE_GAIN_PARMS;
```

Multiply the desired gain setting in dB by 1000. For example, to set the input line gain on a network voice port to -4 dB, set the gain field of NMS_LINE_GAIN_PARMS to -4000.

The following sample code shows how to configure gain applied to a signal received from the network:

```
#include "swidef.h"  /*  Natural Access Switching service          */
#include "mvip95.h"  /*  MVIP-95 definitions                       */
#include "nmshw.h"   /*  NMS hardware-specific definitions         */
*/
DWORD mySetReceiveGain ( SWIHD swihd, SWI_TERMINUS terminus, INT32 gain_dB )
{
     SWI_LOCALTIMESLOT_ARGS  args;
     NMS_LINE_GAIN_PARMS     device ;

     args.localstream      = terminus.stream ;
     args.localtimeslot    = terminus.timeslot ;
     args.deviceid         = MVIP95_ANALOG_LINE_DEVICE ;
     args.parameterid      = MVIP95_INPUT_GAIN ;

     device.gain  =  gain_dB * 1000  ;

     return swiConfigLocalTimeslot (
            swihd,            /* Natural Access switch handle       */
            & args,           /* target device and config item      */
            (void*) & device, /* buffer (defined by parameterid)    */
            sizeof(device));  /* buffer size in bytes               */

}
```

The following sample code shows how to configure line gain applied to a signal transmitted to the network:

```
#include "swidef.h"  /*  Natural Access Switching service          */
#include "mvip95.h"  /*  MVIP-95 definitions                       */
#include "nmshw.h"   /*  NMS hardware-specific definitions         */
*/
DWORD mySetTransmitGain ( SWIHD swihd, SWI_TERMINUS terminus, INT32 gain_dB )
{
     SWI_LOCALTIMESLOT_ARGS  args;
     NMS_LINE_GAIN_PARMS     device ;

     args.localstream      = terminus.stream ;
     args.localtimeslot    = terminus.timeslot ;
     args.deviceid         = MVIP95_ANALOG_LINE_DEVICE ;
     args.parameterid      = MVIP95_OUTPUT_GAIN ;

     device.gain  =  gain_dB * 1000  ;

     return swiConfigLocalTimeslot (
            swihd,            /* Natural Access switch handle       */
            & args,           /* target device and config item      */
            (void*) & device, /* buffer (defined by parameterid)    */
            sizeof(device));  /* buffer size in bytes               */

}
```

# Keyword reference

## Using keywords

The keywords for a given CX 2000 board describe that board's configuration. Some keywords are read/write; others are read-only:

- Read/write (editable) keywords determine how the board is configured when it starts up. Changes to these keywords become effective after the board has been rebooted.
- Read-only (informational) keywords indicate the board's current configuration. Read-only keywords cannot be modified.

This topic describes:

- Setting keyword values
- Retrieving keyword values

**Note:** To learn how to use NMS OAM utilities such as *oamsys* and *oamcfg*, refer to the *NMS OAM System User's Manual*. To learn about setting and retrieving keywords using OAM service functions, refer to the *NMS OAM Service Developer's Reference Manual.*

Plug-in keywords exist in a separate record in the NMS OAM database. They indicate certain board family-level information. CX plug-in keywords are documented in this section.

A keyword has the general syntax:

keyword = ***value***

Keywords are case-insensitive. Values are case-insensitive except where operating system conventions prevail (for example, file names under UNIX). All values are strings, or strings that represent integers. An integer keyword may have a fixed numeric range of legal values. A string keyword may support a fixed set of legal values, or may accept any string.

### *Setting keyword values*

There are several ways to set the values of read/write keywords:

- Use or modify one of the sample board keyword files corresponding to your country and board type. Specify the name of this new file in the `File` statement in *oamsys.cfg*, and run *oamsys* again. Refer to the *NMS OAM System User's Manual* for information about board keyword file syntax.

**Note:** Using *oamsys* reboots all boards in the system.

- Create a new board keyword file, either with additional keywords or keywords whose values override earlier settings.
- Specify parameter settings using the *oamcfg* utility. Refer to the *NMS OAM System User's Manual* for information about *oamcfg*.
- Specify the settings using OAM service functions. Refer to the *NMS OAM Service Developer's Reference Manual* for more information.

**Note:** Keyword values take effect after the board is rebooted.

### *Specifying the keyword level*

When you set keyword values, you specify the NMS OAM database record to modify, either in the system configuration file or the *oamcfg* command line. To set board keywords, specify the board name here. To set AG plug-in level keywords, specify the AG plug-in name (*agplugin.bpi*).

## *Retrieving keyword values*

There are several ways to retrieve the values of read/write and read-only keywords:

- Retrieve the settings using OAM service functions. Refer to the *NMS OAM Service Developer's Reference Manual* for more information.
- Run the *oaminfo* sample program. On the command line, specify the board using either its name (with the `-n` option) or number (with the `-b` option):

  ```
  oaminfo -n boardname
  oaminfo -b boardnum
  ```

  To access AG plug-in level keywords, specify the AG plug-in name on the command line:

  ```
  oaminfo -n agplugin.bpi
  ```

  *oaminfo* returns a complete list of keywords and values. For more information about *oaminfo*, refer to the *NMS OAM Service Developer's Reference Manual*.

# Keyword summaries

This topic provides a summary of the different types of keywords. They are:

- Editable keywords
- Informational keywords
- CX plug-in keywords

## *Editable keyword summary*

The following table summarizes the keywords that can change:

| If you want to... | Use these keywords... |
|---|---|
| Specify whether the board is started or stopped automatically | • AutoStart<br>• AutoStop |
| Specify information about the board | • Encoding<br>• Location.PCI.Bus<br>• Location.PCI.Slot<br>• Name<br>• Number<br>• Product |
| Set up clocking information | • Clocking.HBus.AutoFallBack<br>• Clocking.HBus.ClockMode<br>• Clocking.HBus.ClockSource<br>• Clocking.HBus.ClockSourceNetwork<br>• Clocking.HBus.FallbackClockSource<br>• Clocking.HBus.NetRefSource<br>• Clocking.HBus.NetRefSpeed<br>• Clocking.HBus.SClockSpeed<br>• Clocking.HBus.Segment<br>• Clocking.Type |
| Configure ring cadences | • Ring.Cadences[x].Ton1<br>• Ring.Cadences[x].Toff1<br>• Ring.Cadences[x].Ton2<br>• Ring.Cadences[x].Toff2<br>• Ring.Cadences[x].Ton3<br>• Ring.Cadences[x].Toff3<br>• Ring.Period |
| Configure switching | • SwitchConnections<br>• SwitchDriver.Name |
| Configure debugging information | • DebugMask |
| Specify files to download to the board | • DefaultQslacFile<br>• DSPFile |
| Configure the DSP | • DSP.Image |

| If you want to... | Use these keywords... |
|---|---|
| Enable/disable power to station phones | • ExternalRingerEnable<br>• HighBatteryEnable<br>• LowBatteryEnable<br>• RingVoltageEnable<br>• SignalingLoopbackEnable |

## Informational keyword summary

The following table summarizes informational (read-only) keywords:

| If you want to... | Use these keywords... |
|---|---|
| Retrieve Eeprom information | • Eeprom.AssemblyRevision<br>• Eeprom.Family<br>• Eeprom.MFGWeek<br>• Eeprom.MFGYear<br>• Eeprom.SerialNum<br>• Eeprom.SoftwareCompatibility<br>• Eeprom.TestLevel<br>• Eeprom.TestLevelRev |
| Retrieve power status | • ExternalRingerEnable<br>• HighBatteryEnable<br>• LowBatteryEnable |
| Retrieve the bus type | • Location.Type |
| Retrieve the state of the board | • State |
| Retrieve board driver information | • Driver.Name |
| Retrieve other information | • SignalingLoopbackEnable |

## CX plug-in keywords

The following is a list of keywords in the CX plug-in record in the NMS OAM database:

- Boards[x]
- BootDiagnosticLevel
- DetectedBoards[x]
- Products[x]
- Version.Major
- Version.Minor

## Using the keyword reference

The keywords are presented in detail in the following sections. Each keyword description includes:

| | |
|---|---|
| Syntax | The syntax of the keyword |
| Access | Read/Write or Read-only |
| Type | The data type of the value: String or Integer |
| Default | (Read/Write keywords only) the default value |
| Allowed values | A list of all possible values |
| Example | (Read/Write keywords only) an example of usage |
| Description | A detailed description of the keyword's function |
| See also | A list of related keywords |

# AutoStart

Specifies whether the board automatically starts when *ctdaemon* is started or when the board is inserted using Hot Swap functionality.

### *Syntax*

AutoStart = ***argument***

### *Access*

Read/Write

### *Type*

String

### *Default*

NO

### *Allowed values*

YES | NO

### *Example*

```
AutoStart = NO
```

### *Details*

The Supervisor keyword AutoStartEnabled enables or disables the autostart feature. If AutoStartEnabled is set to YES when ctdaemon is started, the Supervisor starts each board whose AutoStart keyword is set to YES. If AutoStartEnabled is set to NO, no boards are started automatically, regardless of the setting of the AutoStart keyword in the board keyword files.

For details, refer to the *NMS OAM System User's Manual*.

### *See also*

AutoStop

# AutoStop

Specifies whether the board automatically stops when *ctdaemon* is stopped.

### *Syntax*

`AutoStop =` ***argument***

### *Access*

Read/Write

### *Type*

String

### *Default*

NO

### *Allowed values*

YES | NO

### *Example*

```
AutoStart = NO
```

### *Details*

The Supervisor keyword AutoStopEnabled enables or disables the autostop feature. If AutoStopEnabled is set to YES, when *ctdaemon* is stopped the Supervisor stops each board whose AutoStop keyword is set to YES. If AutoStopEnabled is set to NO, no boards are stopped automatically, regardless of the setting of the AutoStop keyword in the board keyword files.

For details, refer to the *NMS OAM System User's Manual*.

### *See also*

AutoStart

# Boards[x]

This array keyword contains a list of all boards managed by the plug-in (the list of all CX 2000 boards that have managed objects in the NMS OAM database.

### *Syntax*

Boards[***x***] = ***board_name***

### *Access*

Read-only (plug-in)

### *Type*

String

### *Allowed values*

Any valid board name.

### *Details*

The NMS OAM Supervisor managed object also contains a Boards[x] array keyword. All values in each plug-in Boards[x] array keyword are added to the keyword at the Supervisor level. This means that you can retrieve the values in the Boards[x] array keyword at the Supervisor level to determine the names of boards currently managed by NMS OAM.

You can retrieve the value of the Supervisor Boards.Count keyword to determine the number of items in the Supervisor Boards[x] array keyword. Retrieve the value of the board plugin Boards.Count keyword to determine the number of items in the plugin Boards[x] array keyword.

For details, refer to the *NMS OAM Service Developer's Reference Manual*.

# BootDiagnosticLevel

Specifies the level of diagnostics during initialization of the board. When disabled (set to `0`) the board ignores any diagnostic errors returned while it is being initialized.

### *Syntax*

BootDiagnosticLevel = ***level***

### *Access*

Read/Write (plug-in level)

### *Type*

Integer

### *Default*

1

### *Allowed values*

-65535 to 65535

### *Example*

```
BootDiagnosticLevel = 1
```

### *Details*

The valid values for ***level*** are 0, and 1. Zero (0) indicates that no diagnostics are performed, and 1 is the maximum level.

If a test fails, the test number is reported back as the error code.

**Note:** Some tests can pass back more than one error code, depending on the options selected and/or the mode of failure.

You must be running *oammon* to view diagnostic results.

# Clocking.HBus.AutoFallBack

Enables or disables clock fallback on the board: whether or not the board automatically switches to a secondary timing reference if its primary timing reference fails.

For information about setting up CT bus clocking, and rules and restrictions for configuring CT bus clocking, refer to Configuring board clocking.

### *Syntax*

Clocking.HBus.AutoFallBack = ***argument***

### *Access*

Read/Write

### *Type*

String

### *Default*

NO

### *Allowed values*

YES | NO

### *Example*

```
Clocking.HBus.AutoFallBack = NO
```

### *Details*

The primary timing reference is specified by the Clocking.HBus.ClockSource keyword. The secondary timing reference is specified by the Clocking.HBus.FallbackClockSource keyword.

**Note:** The *swish* command **queryBoardClock** can be used to determine what timing reference the board is actively using.

For more information about clock fallback, refer to the *NMS OAM System User's Manual*.

### *See also*

Clocking.HBus.ClockMode, Clocking.HBus.ClockSource, Clocking.HBus.FallbackClockSource, Clocking.HBus.NetRefSource

# Clocking.HBus.ClockMode

Specifies whether the board is a clock master driving A_CLOCK or B_CLOCK, or is a clock slave driven by one of these clocks.

For information about setting up CT bus clocking, and rules and restrictions for configuring CT bus clocking, refer to Configuring board clocking.

### *Syntax*

Clocking.HBus.ClockMode = ***setting***

### *Access*

Read/Write

### *Type*

String

### *Default*

STANDALONE

### *Allowed values*

MASTER_A | MASTER_B | SLAVE | STANDALONE

### *Example*

```
Clocking.HBus.ClockMode = MASTER_A
```

### *Details*

Valid entries for this keyword include:

| Value | Description |
|---|---|
| MASTER_A | The board is a clock master, driving A_CLOCK. |
| MASTER_B | The board is a clock master, driving B_CLOCK. |
| SLAVE | The board is a clock slave, deriving its timing from the primary bus master. |
| STANDALONE | The board does not drive any CT bus clocks.<br>**Note:** Connections are not allowed to the board's CT bus timeslots in standalone mode. For more information about this mode, refer to Clocking capabilities. |

For more information about clocking, refer to the *NMS OAM System User's Manual*.

### *See also*

Clocking.HBus.AutoFallBack, Clocking.HBus.ClockSource, Clocking.HBus.FallbackClockSource, Clocking.HBus.NetRefSource

# Clocking.HBus.ClockSource

Specifies the primary timing reference for the board.

For information about setting up CT bus clocking, and rules and restrictions for configuring CT bus clocking, refer to Configuring board clocking.

### *Syntax*

Clocking.HBus.ClockSource = ***argument***

### *Access*

Read/Write

### *Type*

String

### *Default*

OSC

### *Allowed values*

OSC | A_CLOCK | B_CLOCK | NETREF | NETREF2

### *Example*

```
Clocking.HBus.ClockSource = OSC
```

### *Details*

The following table describes allowed values for this keyword for CX 2000 boards:

| Value | Description |
|---|---|
| OSC | Valid only if the board is the primary clock master, or in standalone mode. OSC causes the board to drive the bus clock using the signal from its on-board oscillator.<br>Use this setting only when no external timing reference is available. The on-board oscillator is accurate to 32 ppm (parts per million) and meets the requirements for a Stratum 4E clock. |
| A_CLOCK | Valid only if the board is a clock slave or secondary master. This setting causes the board to act as a slave to A_CLOCK. |
| B_CLOCK | Valid only if the board is a clock slave or secondary master. This setting causes the board to act as a slave to B_CLOCK. |
| NETREF | Valid only if the board is the primary clock master. NETREF causes the board to drive the bus clock using a signal from the NETREF carrier on the CT bus. Another source is driving NETREF. (This source is specified using the Clocking.HBus.NetRefSource keyword.) |

The board returns an error if you select a CT bus clock source and no source is detected.

For more information about clocking, refer to the *NMS OAM System User's Manual*.

### *See also*

Clocking.HBus.AutoFallBack, Clocking.HBus.ClockMode, Clocking.HBus.FallbackClockSource, Clocking.HBus.NetRefSource

# Clocking.HBus.ClockSourceNetwork

Specifies the number of the trunk that the board uses as its external network timing reference for its internal clock.

For information about setting up CT bus clocking, and rules and restrictions for configuring CT bus clocking, refer to Configuring board clocking.

### *Syntax*

Clocking.HBus.ClockSourceNetwork = ***networknum***

### *Access*

Read/Write

### *Type*

Integer

### *Default*

0

### *Allowed values*

0

### *Example*

```
Clocking.HBus.ClockSourceNetwork = 0
```

### *Details*

Since CX 2000 boards do not have digital trunks, this keyword is always set to 0.

### *See also*

Clocking.HBus.ClockSource

# Clocking.HBus.FallbackClockSource

For information about setting up CT bus clocking, and rules and restrictions for configuring CT bus clocking, refer to Configuring board clocking.

### *Syntax*

Clocking.HBus.FallbackClockSource = ***argument***

### *Access*

Read/Write

### *Type*

String

### *Default*

OSC

### *Allowed values*

OSC | A_CLOCK | B_CLOCK | NETREF | NETREF2

### *Example*

```
Clocking.HBus.FallBackClockSource = OSC
```

### *Details*

Specifies the secondary clock reference to use when the primary clock reference fails.

**Note:** If the Clocking.HBus.AutoFallBack keyword is set to NO, this keyword is ignored.

The table below lists allowed values for this keyword for CX 2000 and CX 2000C boards:

| Value | Description |
|---|---|
| OSC | Valid only if the board is a clock master. OSC causes the board to use its on-board oscillator as its secondary timing reference.<br>Use this setting only when no external timing reference is available. The on-board oscillator is accurate to 32 ppm (parts per million) and meets the requirements for a Stratum 4E clock. |
| A_CLOCK | Use the setting if the board is a clock slave to B_CLOCK, and a secondary clock master is driving A_CLOCK. This setting causes the board to use A_CLOCK as its secondary timing reference. |
| B_CLOCK | Use the setting if the board is a clock slave to A_CLOCK, and a secondary clock master is driving B_CLOCK. This setting causes the board to use B_CLOCK as its secondary timing reference. |
| NETREF | Valid only if the board is a clock master. NETREF causes the board to use the signal from the NETREF carrier on the CT bus as its secondary timing reference. Another source is driving NETREF. (This source is specified using the Clocking.HBus.NetRefSource keyword.) |

The board returns an error if you select a CT bus clock source and no source is detected.

For more information about clock fallback, refer to the *NMS OAM System User's Manual*.

### *See also*

Clocking.HBus.AutoFallBack, Clocking.HBus.ClockMode, Clocking.HBus.ClockSource, Clocking.HBus.NetRefSource

# Clocking.HBus.NetRefSource

Specifies a source to drive the NETREF timing signal on the H.100 bus.

For information about setting up CT bus clocking, and rules and restrictions for configuring CT bus clocking, refer to Configuring board clocking.

### *Syntax*

Clocking.HBus.NetRefSource = ***argument***

### *Access*

Read/Write

### *Type*

String

### *Default*

STANDALONE

### *Allowed values*

OSC | STANDALONE

### *Example*

```
Clocking.HBus.NetRefSource = STANDALONE
```

### *Details*

A CX 2000 board can drive this signal only from its internal oscillator. Use this configuration for development purposes only.

For more information about clocking, refer to the *NMS OAM System User's Manual*.

### *See also*

Clocking.HBus.AutoFallBack, Clocking.HBus.ClockMode, Clocking.HBus.ClockSource, Clocking.HBus.FallbackClockSource, Clocking.HBus.NetRefSpeed

# Clocking.HBus.NetRefSpeed

Specifies the speed of the NETREF timing signal on the CT bus.

For information about setting up CT bus clocking, and rules and restrictions for configuring CT bus clocking, refer to Configuring board clocking.

### *Syntax*

Clocking.HBus.NetRefSpeed = ***argument***

### *Access*

Read/Write

### *Type*

String

### *Default*

8K

### *Allowed values*

8K | 1544M | 2048M

### *Example*

```
Clocking.HBus.NetRefSpeed = 8K
```

### *Details*

Only 8K is currently supported.

### *See also*

Clocking.HBus.NetRefSource

# Clocking.HBus.SClockSpeed

Specifies the speed (in MHz) of the driven Sclock, when a board acts as primary clock master.

For information about setting up CT bus clocking, and rules and restrictions for configuring CT bus clocking, refer to Configuring board clocking.

### *Syntax*

Clocking.HBus.SClockSpeed = ***argument***

### *Access*

Read/Write

### *Type*

String

### *Default*

2M

### *Allowed values*

2M | 4M | 8M

### *Example*

```
Clocking.HBus.SClockSpeed = 2M
```

### *See also*

Clocking.HBus.Segment

# Clocking.HBus.Segment

Specifies the CT bus segment to which the board is connected.

For information about setting up CT bus clocking, and rules and restrictions for configuring CT bus clocking, refer to Configuring board clocking.

### *Syntax*

Clocking.HBus.Segment = ***speed***

### *Access*

Read/Write

### *Type*

Integer

### *Default*

1

### *Allowed values*

0 to 65535

### *Example*

```
Clocking.HBus.Segment = 1
```

### *Details*

In most cases, the chassis contains only one segment.

### *See also*

Clocking.HBus.SClockSpeed

# Clocking.Type

Specifies the type of CT bus that the board is compatible with.

For information about setting up CT bus clocking, and rules and restrictions for configuring CT bus clocking, refer to Configuring board clocking.

### *Syntax*

Clocking.Type = ***type***

### *Access*

Read/Write

### *Type*

String

### *Default*

HBus

### *Allowed values*

HBus

### *Example*

```
Clocking.Type = HBus
```

# DebugMask

Specifies the type and level of tracing that the board performs.

### *Syntax*

DebugMask = ***mask***

### *Access*

Read/Write

### *Type*

Integer

### *Default*

0

### *Allowed values*

***mask*** = Any value shown in the following table.

### *Example*

```
DebugMask = 0x00000200
```

### *Details*

You can specify the following DebugMask parameters:

| Value | Description |
|---|---|
| 0x00000001 | Additional initialization messages. |
| 0x00000002 | Legacy initialization messages. |
| 0x00000004 | DLM download and start address. |
| 0x00000008 | Total resources for each DSP. |
| 0x00000080 | DLM resolving and relocation. |
| 0x00000100 | Host Interface up and down messages. |
| 0x00000200 | Inter-manager messages |
| 0x00000400 | All manager messages. |
| 0x80000000 | Available memory. |
| 0xFFFFFFFF | All of the above. |

**Note:** DebugMask settings takes effect immediately. It is not necessary to reboot the board for these settings to take effect.

## DefaultQslacFile

Specifies the QSLAC file.

### *Syntax*

DefaultQslacFile = ***argument***

### *Access*

Read/Write

### *Type*

String

### *Default*

c2allsl6.slc

### *Allowed values*

Any valid file name.

### *Example*

```
DefaultQslacFile = c2allsl6.slc
```

# DetectedBoards[x]

This array keyword contains a list of all boards detected by the CX board plug-in in response to an invocation of the OAM service function **oamDetectBoards**.

### *Syntax*

DetectedBoards[***x***] = ***board_name***

### *Access*

Read-only (plug-in level)

### *Type*

String

### *Allowed values*

Any valid board name.

### *Details*

The array is empty until this function is called.

Board detection actually takes place at the plug-in level: when **oamDetectBoards** is invoked, the Supervisor directs each installed plug-in to detect all boards in the system of a board type that the plug-in supports. The plug-in creates a name for each board, and adds the name to the plug-in DetectedBoards[x] array keyword.

The NMS OAM Supervisor managed object also contains a DetectedBoards[x] array keyword. All values in each plug-in DetectedBoards[x] array keyword are added to the keyword at the Supervisor level. This means that you can retrieve the values in the DetectedBoards[x] array keyword at the Supervisor level to determine the names of all detected boards.

You can retrieve the value of the Supervisor DetectedBoards.Count keyword to determine the number of items in the Supervisor DetectedBoards[x] array keyword. Retrieve the value of the board plugin DetectedBoards.Count keyword to determine the number of items in the plugin DetectedBoards[x] array keyword.

For details, refer to the *NMS OAM Service Developer's Reference Manual*.

## Driver.Name

Indicates the operating system independent (root name) name of the driver.

### *Syntax*

Driver.Name = ***name***

### *Access*

Read-only

### *Type*

String

### *Allowed values*

Not applicable.

## DSPFile

Specifies the name of the file to be loaded into the DSP.

### *Syntax*

DSPFile = ***argument***

### *Access*

Read/Write

### *Type*

String

### *Default*

cx100.dsp

### *Allowed values*

Any valid file name.

### *Example*

```
DSPFile = cx100.dsp
```

## DSP.Image

Specifies the digital signal processor (DSP) operating system to use on the DSP.

### *Syntax*

DSP.Image = ***filename***

### *Access*

Read/Write

### *Type*

File name

### *Default*

cx100.dsp

### *Allowed values*

Valid DSP image file name.

### *Example*

```
DSP.Image = cx100.dsp
```

## Eeprom.AssemblyRevision

Indicates the hardware assembly level.

### *Syntax*

Eeprom.AssemblyRevision = ***number***

### *Access*

Read-only

### *Type*

Integer

### *Allowed values*

Not applicable.

### *See also*

Eeprom.Family, Eeprom.MFGWeek, Eeprom.MFGYear, Eeprom.SerialNum, Eeprom.SoftwareCompatibility, Eeprom.TestLevel, Eeprom.TestLevelRev

## Eeprom.Family

Indicates the board family.

### *Syntax*

Eeprom.Family = ***family_ID_number***

### *Access*

Read-only

### *Type*

Integer

### *Allowed values*

Not applicable.

### *See also*

Eeprom.AssemblyRevision, Eeprom.MFGWeek, Eeprom.MFGYear, Eeprom.SerialNum, Eeprom.SoftwareCompatibility, Eeprom.TestLevel, Eeprom.TestLevelRev

## Eeprom.MFGWeek

Indicates the week of the last full test.

### *Syntax*

Eeprom.MFGWeek = ***week_number***

### *Access*

Read-only

### *Type*

Integer

### *Allowed values*

Not applicable.

### *See also*

Eeprom.AssemblyRevision, Eeprom.Family, Eeprom.MFGYear, Eeprom.SerialNum, Eeprom.SoftwareCompatibility, Eeprom.TestLevel, Eeprom.TestLevelRev

## Eeprom.MFGYear

Indicates the year of the last full test.

### *Syntax*

Eeprom.MFGYear = ***year***

### *Access*

Read-only

### *Type*

Integer

### *Allowed values*

Not applicable.

### *See also*

Eeprom.AssemblyRevision, Eeprom.Family, Eeprom.MFGWeek, Eeprom.SerialNum, Eeprom.SoftwareCompatibility, Eeprom.TestLevel, Eeprom.TestLevelRev

## Eeprom.SerialNum

Indicates the serial number of the board.

### *Syntax*

Eeprom.SerialNum = ***number***

### *Access*

Read-only

### *Type*

Integer

### *Allowed values*

0 to 2147483647

### *Details*

This number is factory-configured, and is unique to each board.

### *See also*

Eeprom.AssemblyRevision, Eeprom.Family, Eeprom.MFGWeek, Eeprom.MFGYear, Eeprom.SoftwareCompatibility, Eeprom.TestLevel, Eeprom.TestLevelRev

# Eeprom.SoftwareCompatibility

Indicates the minimum software revision level.

### *Syntax*

Eeprom.SoftwareCompatibility = ***level***

### *Access*

Read-only

### *Type*

Integer

### *Allowed values*

Not applicable.

### *See also*

Eeprom.AssemblyRevision, Eeprom.Family, Eeprom.MFGWeek, Eeprom.MFGYear, Eeprom.SerialNum, Eeprom.TestLevel, Eeprom.TestLevelRev

# Eeprom.TestLevel

Identifies the test level of the EEPROM.

### *Syntax*

Eeprom.TestLevel = ***argument***

### *Access*

Read-only

### *Type*

Integer

### *Allowed values*

0 to 65535

### *See also*

Eeprom.AssemblyRevision, Eeprom.Family, Eeprom.MFGWeek, Eeprom.MFGYear, Eeprom.SerialNum, Eeprom.SoftwareCompatibility, Eeprom.TestLevelRev

# Eeprom.TestLevelRev

Identifies the test level revision of the EEPROM.

### *Syntax*

Eeprom.TestLevelRev = ***argument***

### *Access*

Read-only

### *Type*

Integer

### *Allowed values*

0 to 255

### *See also*

Eeprom.AssemblyRevision, Eeprom.Family, Eeprom.MFGWeek, Eeprom.MFGYear, Eeprom.SerialNum, Eeprom.SoftwareCompatibility, Eeprom.TestLevel

## Encoding

Specifies the DSP and CODEC hardware companding mode.

### *Syntax*

Encoding = ***mode***

### *Access*

Read/Write

### *Type*

String

### *Default*

MuLaw

### *Allowed values*

ALaw | MuLaw

### *Example*

```
Encoding = MuLaw
```

## ExternalRingerEnable

Enables use of external ringing voltage.

### *Syntax*

ExternalRingerEnable = ***argument***

### *Access*

Read/Write

### *Type*

String

### *Default*

Enable

### *Allowed values*

Enable | Disable

### *Example*

```
ExternalRingerEnable = Enable
```

## HighBatteryEnable

Enables or disables high battery.

### *Syntax*

HighBatteryEnable = ***argument***

### *Access*

Read/Write

### *Type*

String

### *Default*

Enable

### *Allowed values*

Enable | Disable

### *Example*

```
HighBatteryEnable = Enable
```

### *See also*

LowBatteryEnable

# Location.PCI.Bus

Specifies the board's PCI location.

### *Syntax*

Location.PCI.Bus = ***busnum***

### *Access*

Read/Write

### *Type*

Integer

### *Default*

0

### *Allowed values*

0 - 255

### *Example*

```
Location.PCI.Bus = 0
```

### *Details*

Every slot in the system is identified by a unique logical bus and slot number. A PCI board is identified in the configuration file by specifying its logical bus and slot number.

A PCI board's address and interrupt is automatically set by the system. This statement along with the Location.PCI.Slot keyword assigns the board number to the physical board.

Use *pciscan* to determine the logical bus and slot assigned to boards. For more information about this utility, refer to the *NMS OAM System User's Manual*.

### *See also*

Location.PCI.Slot, Location.Type

# Location.PCI.Slot

Defines the logical slot location of the board on the PCI bus.

### *Syntax*

Location.PCI.Slot = ***slotnum***

### *Access*

Read/Write

### *Type*

Integer

### *Default*

0

### *Allowed values*

0 - 255

### *Example*

```
Location.PCI.Slot = 1
```

### *Details*

Every PCI slot in the system is identified by a unique bus and slot number. A PCI board is specified in the system configuration file by specifying its bus and slot number.

A PCI board's address and interrupt is automatically set by the system. This statement along with Location.PCI.Bus assigns a board number to the physical board.

Use *pciscan* to determine the logical bus and slot assigned to the boards. For more information about this utility, refer to the *NMS OAM System User's Manual*.

### *See also*

Location.PCI.Bus, Location.Type

## Location.Type

Indicates the bus type.

### *Syntax*

Location.Type = ***slottype***

### *Access*

Read-only

### *Type*

String

### *Allowed values*

PCI

## LowBatteryEnable

Enables or disables low battery.

### *Syntax*

LowBatteryEnable = ***argument***

### *Access*

Read/Write

### *Type*

String

### *Default*

Enable

### *Allowed values*

Enable | Disable

### *Example*

```
LowBatteryEnable = Enable
```

### *See also*

HighBatteryEnable

## Name

Specifies the board name.

### *Syntax*

Name = ***name***

### *Access*

Read/Write at board level; read-only at plug-in level

### *Type*

String

### *Default*

The product name, followed by a space and then a numeral. For example: CX 2000C-32 0.

### *Allowed values*

(At board level) any valid board name.

(At plug-in level) cx.bpi

### *Example*

```
Name = My_CX_2000
```

### *Details*

The name can be changed by modifying this keyword.

The plug-in Name keyword is read-only. It contains the name of the plug-in (cx.bpi).

### *See also*

Number

# Number

Specifies the logical board number for this board.

### *Syntax*

Number = ***xxx***

### *Access*

Read/Write

### *Type*

Integer

### *Default*

0

### *Allowed values*

0 - 31

### *Example*

```
Number = 0
```

### *Details*

By default, the NMS OAM Supervisor creates a board number that is guaranteed to be unique within a chassis. However, you can override this value.

### *See also*

Name

## Product

Indicates the product type of the CX 2000 board.

### *Syntax*

Product = ***product name***

### *Access*

Read-only

### *Type*

String

### *Default*

None.

### *Allowed values*

CX 2000

### *Example*

```
Product = CX 2000
```

# Products[x]

Contains a list of all products supported by the CX plug-in.

### *Syntax*

Products[***x***] = ***product_type***

### *Access*

Read-only (CX plug-in level)

### *Type*

String

### *Allowed values*

CX 2000-32 | CX 2000-16

### *Details*

Model CX 2000-16 is not available.

The contents of the Products[x] keywords in the CX plug-in (and all other installed plug-ins) are added to the NMS OAM Supervisor array keyword Products[x] at startup. This means that you can retrieve the values in the Supervisor keyword Products[x] to determine all products supported by all installed plug-ins.

You can retrieve the value of the Supervisor Products.Count keyword to indicate the number of items in the Supervisor Products[x] array keyword. Retrieve the value of the board plugin Products.Count keyword to determine the number of items in the plugin Products[x] array keyword.

# Ring.Cadences[x].Toff1

Determines the length of the interval after the first ring in cadence ***x***.

### *Syntax*

Ring.Cadences[***x***].Toff1 = ***n***

### *Access*

Read/Write

### *Type*

Integer

### *Default*

| Ring.Cadences[x] | Toff1 default |
|---|---|
| 0 | 0 |
| 1 | 800 |
| 2 | 400 |

### *Allowed values*

***n*** = 0 to 32766 ms

***x*** = 0 to 2

### *Example*

```
Ring.Cadences[1].Toff1 = 800
```

### *Details*

For more information about cadencing, refer to Configuring ring cadences.

### *See also*

Ring.Cadences[x].Toff2, Ring.Cadences[x].Toff3, Ring.Cadences[x].Ton1, Ring.Cadences[x].Ton2, Ring.Cadences[x].Ton3, Ring.Period

# Ring.Cadences[x].Toff2

Determines the length of the interval after the second ring in cadence *x*.

### *Syntax*

Ring.Cadences[***x***].Toff2 = ***n***

### *Access*

Read/Write

### *Type*

Integer

### *Default*

| Ring.Cadences[x] | Toff2 default |
|---|---|
| 0 | 0 |
| 1 | 0 |
| 2 | 400 |

### *Allowed values*

***n*** = 0 to 32766 ms

***x*** = 0 to 2

### *Example*

```
Ring.Cadences[1].Toff2 = 0
```

### *Details*

For more information about cadencing, refer to Configuring ring cadences.

### *See also*

Ring.Cadences[x].Toff1, Ring.Cadences[x].Toff3, Ring.Cadences[x].Ton1, Ring.Cadences[x].Ton2, Ring.Cadences[x].Ton3, Ring.Period

# Ring.Cadences[x].Toff3

Determines the length of the interval after the third ring in cadence ***x***.

### *Syntax*

Ring.Cadences[***x***].Toff3 = ***n***

### *Access*

Read/Write

### *Type*

Integer

### *Default*

| Ring.Cadences[x] | Toff3 default |
|---|---|
| 0 | 4000 |
| 1 | 4000 |
| 2 | 4000 |

### *Allowed values*

***n*** = 0 to 32766 ms

***x*** = 0 to 2

### *Example*

```
Ring.Cadences[1].Toff3 = 4000
```

### *Details*

Ring.Cadences[x].Toff3 must be at least 2/3 of the duration of Ring.Period. For more information about cadencing, refer to Configuring ring cadences.

### *See also*

Ring.Cadences[x].Toff1, Ring.Cadences[x].Toff2, Ring.Cadences[x].Ton1, Ring.Cadences[x].Ton2, Ring.Cadences[x].Ton3, Ring.Period

# Ring.Cadences[x].Ton1

Determines the length of the first ring in cadence ***x***.

### *Syntax*

Ring.Cadences[***x***].Ton1 = ***n***

### *Access*

Read/Write

### *Type*

Integer

### *Default*

| Ring.Cadences[x] | Ton1 default |
|---|---|
| 0 | 2000 |
| 1 | 600 |
| 2 | 400 |

### *Allowed values*

***n*** = 0 to 32766 ms

***x*** = 0 to 2

### *Example*

```
Ring.Cadences[1].Ton1 = 600
```

### *Details*

For more information about cadencing, refer to Configuring ring cadences.

### *See also*

Ring.Cadences[x].Toff1, Ring.Cadences[x].Toff2, Ring.Cadences[x].Toff3, Ring.Cadences[x].Ton2, Ring.Cadences[x].Ton3, Ring.Period

# Ring.Cadences[x].Ton2

Determines the length of the second ring in cadence ***x***.

### *Syntax*

Ring.Cadences[***x***].Ton2 = ***n***

### *Access*

Read/Write

### *Type*

Integer

### *Default*

| Ring.Cadences[x] | Ton2 default |
|---|---|
| 0 | 0 |
| 1 | 600 |
| 2 | 400 |

### *Allowed values*

***n*** = 0 to 32766 ms

***x*** = 0 to 2

### *Example*

```
Ring.Cadences[1].Ton2 = 600
```

### *Details*

For more information about cadencing, refer to Configuring ring cadences.

### *See also*

Ring.Cadences[x].Toff1, Ring.Cadences[x].Toff2, Ring.Cadences[x].Toff3, Ring.Cadences[x].Ton1, Ring.Cadences[x].Ton3, Ring.Period

# Ring.Cadences[x].Ton3

Determines the length of the third ring in cadence ***x***.

### *Syntax*

Ring.Cadences[***x***].Ton1 = ***n***

### *Access*

Read/Write

### *Type*

Integer

### *Default*

| Ring.Cadences[x] | Ton3 default |
|---|---|
| 0 | 0 |
| 1 | 0 |
| 2 | 400 |

### *Allowed values*

***n*** = 0 to 32766 ms

***x*** = 0 to 2

### *Example*

```
Ring.Cadences[1].Ton3 = 0
```

### *Details*

For more information about cadencing, refer to Configuring ring cadences.

### *See also*

Ring.Cadences[x].Toff1, Ring.Cadences[x].Toff2, Ring.Cadences[x].Toff3, Ring.Cadences[x].Ton1, Ring.Cadences[x].Ton2, Ring.Period

# Ring.Period

Specifies the duration of a full cycle of rings (usually six seconds).

### *Syntax*

Ring.Period = ***n***

### *Access*

Read/Write

### *Type*

Integer

### *Default*

6000

### *Allowed values*

***n*** = 6 to 32766 milliseconds

### *Example*

```
Ring.Period = 6000
```

### *Details*

For more information about cadencing, refer to Configuring ring cadences.

### *See also*

Ring.Cadences[x].Toff1, Ring.Cadences[x].Toff2, Ring.Cadences[x].Toff3, Ring.Cadences[x].Ton1, Ring.Cadences[x].Ton2, Ring.Cadences[x].Ton3

## RingVoltageEnable

Enables or disables ring voltage.

### *Syntax*

RingVoltageEnable = ***argument***

### *Access*

Read/Write

### *Type*

String

### *Default*

Enable

### *Allowed values*

Enable | Disable

### *Example*

```
RingVoltageEnable = Enable
```

## SignalingLoopbackEnable

Enables or disables signaling loopback.

### *Syntax*

SignalingLoopbackEnable = ***argument***

### *Access*

Read/Write

### *Type*

String

### *Default*

Disable

### *Allowed values*

Enable | Disable

### *Example*

```
SignalingLoopbackEnable = Disable
```

## State

Indicates the state of the physical board.

***Syntax***

State = ***argument***

***Access***

Read-only

***Type***

String

***Allowed values***

IDLE | BOOTED| TESTING

# SwitchConnections

Specifies whether the board nails up default switch connections when initialized.

### *Syntax*

SwitchConnections = ***mode***

### *Access*

Read/Write

### *Type*

String

### *Default*

Auto

### *Allowed values*

Yes | No | Auto

### *Example*

```
SwitchConnections = No
```

### *Details*

Valid entries include:

| Value | Description |
|---|---|
| No | Does not nail up switch connections. |
| Yes | Nails up switch connections regardless of the Clocking.HBus.ClockMode keyword setting. |
| Auto | Nail up connections automatically if the Clocking.HBus.ClockMode keyword is set to StandAlone. |

When running the Point-to-Point Switching service, set SwitchConnections = No. Use the *ppx.cfg* file to define default connections. For more information, refer to the *Point-to-Point Switching Service Developer's Reference Manual*.

### *See also*

Clocking.HBus.ClockMode

## SwitchDriver.Name

Specifies the operating system independent name (that is, the root name) of the board switching driver.

### *Syntax*

SwitchDriver.Name = ***filename***

### *Access*

Read/Write

### *Type*

String

### *Default*

cxsw

### *Allowed values*

Any valid switch driver name.

### *Example*

```
SwitchDriver.Name = cxsw
```

### *See also*

SwitchConnections

## Version.Major

Indicates the major version number of the plug-in.

### *Syntax*

Version.Major = ***number***

### *Access*

Read-only (plug-in level)

### *Type*

Integer

### *Allowed values*

Any integer.

### *Details*

The keyword value is incremented when a change is made to the plug-in.

### *See also*

Version.Minor

## Version.Minor

Indicates the minor version number of the plug-in.

### *Syntax*

Version.Minor = ***number***

### *Access*

Read-only (plug-in level)

### *Type*

Integer

### *Allowed values*

Any integer.

### *Details*

The keyword value is incremented when a change is made to the plug-in.

### *See also*

Version.Major

# CX 2000 hardware specifications

## General Specifications

The specifications in this section apply to the CX 2000-32.

| Feature | Specification |
|---|---|
| TDM Bus | Features one complete H.100 bus interface with MVIP-95 enhanced-compliant switching |
| Processing Power | One TMS320C549 DSP |
| Software Development Kits | Natural Access 2002-1 or later |

### *Host interface*

| Feature | Specification |
|---|---|
| Electrical | 5 volt PCI bus interface compliant with the PCI specification, version 2.2. The PCI interface is a 33 Mhz, 32-bit target device |
| Mechanical | Designed to the PCI specification |
| Bus Speed | 33 MHz maximum |
| I/O Mapped Memory | Memory mapped interface for efficient block data transfers |
| Addresses/Interrupts | Automatically configured by PCI BIOS (no jumpers or switches) |
| BIOS | Required conformance to PCI specification version 2.2 |

### *Telephone interface*

At the end of the adapter cable on the CX 2000 board, there are two RJ-21 connectors with 24 circuits on the first, and eight circuits on the second. See the following illustration on Cable (NMS P/N 32590) Connector pinouts, and the tables on Ring pin and Tip pin for pin assignments.

### *H.100 compliant interface*

- Switchable access to any of 4096 H.100 timeslots.
- H.100 clock master or clock slave (software-selectable).
- Compatible with any H.100-compliant telephony interface.

# Environment

| Feature | Description |
|---|---|
| Operating Temperature | 0° C to 50° C |
| Storage Temperature | -20° C to 70° C |
| Humidity | 5% to 80%, non-condensing |

## *Maximum board operating temperature*

| Thermometer ID | In temperature controlled laboratory environment | In the field |
|---|---|---|
| 0 | 65° C | 90° C |
| 1 | 65° C | 90° C |
| 2 | 60° C | 90° C |
| 3 | 60° C | 90° C |
| 4 | 60° C | 90° C |

For more information about board temperatures, refer to Verifying the board's operating temperature.

# Power requirements

| State | Requirement |
|---|---|
| BD_SEL# Active/CX 2000 Active | 1 A maximum @ 5 V |

## *Telco power per board*

| Input power | Current | Maximum voltage |
|---|---|---|
| -24 to-30 V DC (low battery) | 1 A maximum | 30.5 V DC |
| -24 to -48 V DC (high battery) | 1 A maximum (with 32 stations active) | 52 V DC |
| Ring voltage | 0.250 A (with 20 ports active) | 92 V AC, 52 V DC |

## Signaling module

| Specification | Value |
|---|---|
| Return loss<br>(ref. 600 Ohms +2.2 µF standard) | 20 dB minimum (ERL) |
| 4 to 2 wire gain tolerance | +/- 1 dB |
| 4 to 2 wire gain range | +6 to -6 dB |
| 2 to 4 wire gain tolerance | +/- 1 dB |
| 2 to 4 wire gain range | +6 to -6 dB |
| Frequency response<br>300 Hz - 3200 Hz. reference to 1 kHz | +/- 1 dB |
| Trans-hybrid loss | 20 dB minimum @ 300 Hz-3400 Hz into 600 Ohms |
| Signal overload level | +3 dBm at 0 dB gain |
| T-R input impedance (300 - 3200 Hz) | 600 ohms |
| Idle channel noise through connection | < 20 dB rnC |
| Crosstalk transmit to receive channels | < -70 dB @ 1 kHz |
| Operating loop current | Maximum: 25 to 30 mA<br>Minimum: 10 mA |
| Maximum ringer equivalence load | 1.5 |
| Ringing voltage output | CX 2000 power supply module: 86 V AC, -48 V DC |

# Compliance and approvals

NMS Communications obtains board-level approvals certificates for supported countries. Refer to the NMS web site (*www.nmscommunications.com*) for a list of countries where NMS has obtained approval for the board.

In some countries you may require, in addition to the approval obtained by NMS for the board and its associated software, a system-level approval before connecting the system to the public network. To learn what approvals you require, contact the appropriate regulatory authority in the target country.

## *EMC*

| | |
|---|---|
| US and Canada | FCC Part 15 Class A (with shielded cables and STP cable for ringing power supply) |
| EU | EN55022 (1998) Class B (with shielded cables and STP cable for ringing power supply)<br>EN55024 (1998) (with shielded cables and STP cable for ringing power supply) |
| Australia | AS/NZS3548, CISPR22 |

## *Safety*

| | |
|---|---|
| US and Canada | UL1950 3rd edition & CAN/CSA C22.2 No. 950-95<br>Note: These approvals are limited to telephone cabling that stays within the building. |
| EU | EN60950 (1992) and Amendments 1 - 4 |
| Australia | ACA TS001, IEC 950, AS/NZS 3260 |

## *Telecom*

| | |
|---|---|
| US and Canada | FCC Part 68 |
| Canada | CS03 |

**Note:** CX 2000 boards do not connect to the public network. Therefore, telecom approvals are generally not required.

| | |
|---|---|
| ***Caution:*** | *The CX 2000 board is intended to be installed in a CSA certified equipment in the field by the user in manufacturer's defined operator access area. Check the equipment operating/installation instructions and/or equipment manufacturer to verify/confirm if your equipement is suitable for user-installed application boards.* |

| | |
|---|---|
| ***Attention:*** | *Cette carte d'extension, modèle CX 2000 est destinée à être installée par l'utilisateur, sur place et à l'intérieur de la zone définie par le fabricant, dans un appareil certifié CSA. Consulter le mode d'emploi ou le fabricant de l'appareil pour vérifier ou confirmer si l'utilisateur peut y installer lui-même des cartes péripheriques.* |

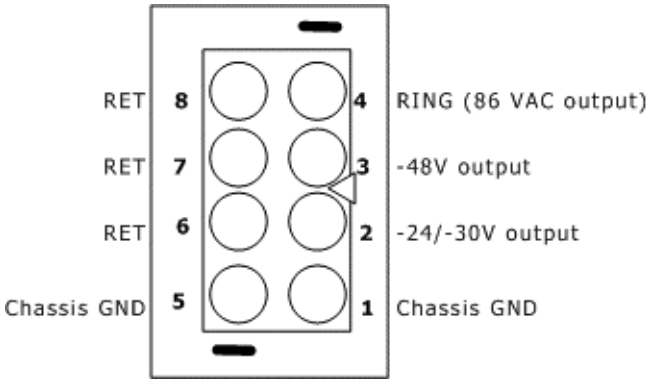
# Other hardware specifications

## Rack mount ringing power supply specifications

The specifications in this section apply to the NMS rack mount ringing power supply.

| | |
|---|---|
| Description | A 19" w x 5.25" h rack mount chassis containing four separate modules, each rated for 2.2A (DC) and 0.1 7A (DC) output current. The modules operate in a parallel mode output current. |
| Input power | 90-132/180-264 V AC 47-63 Hz automatic range selection. |
| DC output | 24V DC/ 30V DC and -48V DC @ 2.2 A/module total. |
| DC output regulation | Less than 1%. |
| DC output ripple | Less than 0.5% peak to peak. |
| Output isolation | 24V DC and -48V DC isolated from chassis ground. AC output is referenced by -48V DC output. |
| AC output | 0.17A/module with 100% duty cycle. |
| AC output frequency | 17, 20, 25, or 50 Hz +/-1 0% switch selectable. |
| AC output regulation | Less than 10% for the full input voltage range and no load to full load. 90V AC maximum. |
| AC output wave form | Simulated sine wave with less than 20% distortion. |
| Current limiting | All outputs have current limiting with full protection and auto recovery. |
| Output indicator | Green LED on the module indicates that all outputs are operating. External signal indicates an alarm condition. |
| Module failure protection | A failure in any module results in its outputs being automatically taken offline. |
| Temperature range | Ambient temperature range is 0° C to 50° C for full load operation. |
| EMI design standards | Approved to FCC 20780, Part 15, Class B, EN55022, Class B, and EN50082-1. |
| Safety design standards | Approved to EN60950, UL1950 3rd edition and 1/24/00 CSA C22.2-950. |

The following illustration shows the NMS power supply pinouts:




*NMS power supply pinouts*

The mating connector is Positronics PLBO8M0050 with MC116N pins.

## Standards

CompactPCI standards and specifications are maintained by the PCI Industrial Computers Manufacturers Group (PICMG). For CompactPCI information, contact

PICMG

c/o Rogers Communications
401 Edgewater Place, Suite 500
Wakefield, MA 01880
Tel: 781-246-9318
Fax: 781-224-1239
www.picmg.org

For the PCI specification, contact the PCI SIG at

PCI Special Interest Group
2575 N.E. Kathryn #17
Hillsboro, Oregon 97124
Phone : 800-433-5177 (Inside the U.S.)
503-693-6360 (Outside the U.S.)
Fax: 503-693-8344
pcisig@pcisig.com
www.pcisig.com

For GO-MVIP information, contact

GO-MVIP, Inc.
3220 N Street, NW, Suite 360
Washington, DC 20007
Tel: 800-NOW-MVIP (US and Canada)
Tel: 903-769-3717; Fax: 903-769-3818
info@mvip.org

# Demonstration program

## Using CX demonstration programs

This appendix presents *cditest*, a program shipped with Natural Access and CX software. *cdicc* and *cdipbx* demonstrate how to access and perform operations with CX 2000 boards.

The following demonstration programs are provided with the CX software:

| Program | Description | Where documented |
|---|---|---|
| *cditest* | Verifies that the CDI service is operational and demonstrates CDI service functions. | This manual |
| *cdicc* | Demonstrates a call center application using the CDI service, with mixed board support in a single application. | *CDI Service Developer's Reference Manual* |
| *cdipbx* | Demonstrates a PBX application using the CDI service. | *CDI Service Developer's Reference Manual* |

Before you start a demonstration program, ensure that

- Natural Access is properly installed.
- The boards are properly installed.
- One or more boards are booted.

# Interactive test program: cditest

### *Name*

*cditest*

### *Purpose*

Demonstrates CDI service functions executing in asynchronous mode. *cditest* is used to:

- Verify proper installation and operation of the CDI service.
- Expose working examples of Natural Access and CDI service functions.

### *Usage*

`cditest [`***options***`]`

where ***options*** are:

| Option | Description | Default |
|---|---|---|
| `-b` ***n*** | Board number ***n***. | 0 |
| `-s [`***strm:***`]`***slot*** | DSP [stream] and timeslot. | 4:0 |
| `-?` | Help | |

### *Featured functions*

Natural Access system functions and CDI service functions are featured.

### *Description*

*cditest* is a menu-driven interactive program. Enter one- and two-letter commands to execute Natural Access and CDI service commands.

**Note:** cditest operates only if default switch connections are nailed up on the board (SwitchConnections=Yes, or SwitchConnections=Auto and Clocking.HBus.ClockMode=STANDALONE, or the connections are made in another way).

### *Procedure*

The following procedure assumes that you are testing on a CX 2000 board with an external power supply and an attached telephone:

To run *cditest*:

1. Navigate to the demonstration program directory:

   | Operating system | Path |
   |---|---|
   | Windows 2000 | `nms\ctaccess\demos\cditest` |
   | UNIX | `opt/nms/ctaccess/demos/cditest` |

2. Start *cditest* by entering the following at a command prompt:

   ```
   cditest -b n -s [stream:]slot
   ```

   Where ***n***, ***stream*** and ***slot*** are the number and PCI stream and slot of the CX 2000 or CX 2000C board. For example, to open port 01 on board 0, enter:

   ```
   ditest -b0 -s4:0
   ```

A menu of one- and two-letter commands is displayed.

3. Enter OP to create a context and open the CDI service.

   CTAEVN_OPEN_SERVICES_DONE is displayed on your screen.

4. Enter any commands with which you want to experiment.

   For example, the ET command enables the battery. EB enables the bit detector.

   The stop event fetch (SE), get one event (GE), and continue event fetch (CE) commands allow you to step through board operations one at a time, retrieving events with each step. You can use these commands to answer questions you may have relating to state/event combinations.

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